THE GLASS INDUSTRY

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MILLVILLE'S NEW FURNACE ROOM

Armstrong Cork Co. consolidates its two Whitall-Tatum plants at Millville, N. J., and adds a new furnace-room. Glass tanks are straight-lined and equipped with the new Hartford batch feeding system. Improvements are the first step in a three-year program of plant betterment.

Those familiar with the glass container manufacturing activities in New Jersey will remember that the Whitall-Tatum Company operated two plants in Millville. These two plants were known as the Upper plant and the Lower plant and were situated several blocks distant from each other. When the Armstrong Cork Company acquired the Whitall-Tatum interests, it was decided that this set-up was uneconomical, inasmuch as the main operating staff was located at the Lower plant, which was the larger of the two. It was therefore decided that the two plants should be consolidated into one. The first phase of this plant consolidation program has recently been completed, most of the heavy equipment, storage sheds, and the like being removed from the Upper plant and transferred to the Lower plant. As sufficient land was available for expansion, a new addition was also erected next to the existing factory building at the Lower plant. This addition has been built in such a manner so as to be a continuation of the old factory and has been designed so as to follow the straight line production methods which have been in use in the plant. This new addition, being the first step in the plant consolidation program, was built to house the two new furnaces which are to take the place of the two left in the old dismantled plant. The plant capacity, as far as the number of furnaces are concerned, remains the same as before.

The new building is of the usual structural and corrugated steel construction with glazed steel sash, and its overall dimensions are approximately 200 ft. in length and 180 ft. in width. A brick wall partition separates the furnace room and hot-end from the packing room and divides the building into two smaller rooms, both of which are approximately 100 ft. long and 180 ft. wide. Due to the construction of the building, both rooms are provided with sufficient windows so that under normal daylight conditions artificial lighting is not a necessity. Ventilation in the hot-end and at the furnace platform is provided for by pivoted corrugated steel panels which may be swung out in sections and thus provides ample and variable ventilating facilities.

The two new continuous furnaces were designed and constructed by the Forter-Teichmann Company of Pittsburgh, Pennsylvania. Both furnaces are of side port construction and are exactly similar in design and dimensions, the melting-end dimensions being 17′ x 24′ with a 30″ metal line. Each furnace is rated at a daily pull of 75 tons. In the furnace construction electrocast refractory has been used in the melting-end side walls, the working-end side walls, the rear gable walls, doghouse, breast walls, port arches, sills and jams. Clay refractory block has been used for the furnace bottoms and the crown is of the usual silica brick construction. The checker chamber walls are provided with literally hundreds of plugs to allow the thorough and periodic cleaning of the checkers. In addition, the flues leading into the checkers are provided with dampers which allow one or all of the checker passages to be shut off in case the checker system need replacing. This method of cutting

Fig. 1. The "E" furnace, taken from the hot end. This is Forter-Teichmann designed and is rated to pull 75 tons per day.

out portions of the checker system for replacement or repair has been successfully used on these furnaces.

The Hartford-Empire triangular doghouse and the Hartford-Empire automatic method of feeding are used on both of these furnaces. A complete description of this doghouse and the method of feeding was given in the February, 1941, issue of THE GLASS INDUSTRY.

As is customary with this type of furnace the "under the port" method of firing is used, Bunker "C" oil being used for continuous operation, with No. 7 gas oil as a stand-by fuel. Both furnaces are fired by the means of "Best" burners. These burners are automatically removed from the burner hole as the furnace is reversed. When the burners are out of their firing position a refractory block closes up the burner hole. The average oil consumption with flint glass at a furnace temperature of 2700°F and for a 60 ton pull is approximately 3600 gallons of oil per day. A simple calculation shows that under these conditions 60 gallons of oil is required to melt a ton of glass. This figure compared very favorably with what is being accomplished on other oil fired furnaces.

Fig. 2. General view of "D" factory, looking toward the hot end.

Figure 1 shows a view of the new "D" furnace, looking towards the hot-end. The three left side checkers and the checker plugs may be easily seen. Figure 2 is a view of the new "E" furnace taken from the hot-end.

On the furnace control board shown in Figure 3, the left side of the board contains a Bristol Oil Temperature Recorder, a Bailey Fuel-Air Ratio Meter and Recorder, and a Leeds and Northrup Temperature Reversal Instrument. The right hand side of the instrument board contains signal lights, oil gauges, and the necessary oil and air reversing valves. At present the fuel-air ratio meter is not in use but will be placed in operation as soon as the remainder of the forced draft equipment is ready. At present the furnaces are running on natural draft.

Fig. 3. The furnace control board with the recording instruments and temperature reversal on the left side. On the right side are the signal lights, gauges and the reversing valves.

In Figure 4 a view of the charging-end and the furnace platform is shown and illustrates the method used in handling the batch. The batch is mixed in the batch house, conveyed to the building by an electric truck, and received at the rear end of the furnace platform on the ground floor level. The batch buckets, which contain two tons of mixed batch, are then lifted to the furnace floor by means of a Sheppard hoist and conveyed to either the batch feeder or to storage positions alongside the furnaces by the means of an American Monorail Batch Conveying System.

Each furnace has five Hartford-Empire feeders. At the time of the visit by THE GLASS INDUSTRY representative one insulator machine, one Lynch No. 10 machine, and three I.S. machines were being used on the "D" furnace, while the "E" furnace was supplying glass to five I.S. machines. All of these machines feed their production into ten Hartford-Empire lehrs. Various types of lehrs, including the "B," "E," "M," and "L' are used. The lehr widths are 34 in., 44 in., and 60 in.

A general view of the new packing room is shown in Figures 5. Two packers are stationed at opposite sides of the exit end of each lehr. Knocked-down cartons, partitions, and liners are plaed so that they are easily available to each packer. The packer assembles the carton with its liners and partitions, fills it with selected bottles and then places it on the conveyor belt, which is located towards the rear of and about 4 ft. above the exit end of the lehr. This conveyor runs from the "A," "B," and "C" factories through the new addition and then downstairs to the sealing room. The total length of this conveyor is approximately 800 ft. long and probably is the longest continuous conveyor to be found in the glass container industry. This conveying equipment was designed by the Alvey Conveyor Manufacturing Company. The off-ware is placed in boxes alongside of the packer and then manually transferred to storage trucks located along the packing room rear wall. When the cullet trucks are filled they are picked up by a pull tractor and carried to the cullet storage. It is planned to eliminate this method of off-ware disposal by placing chutes at the end of each lehr which will feed to trucks located in the basement of the packing room.

As the packed cartons reach the sealing room, which is located under the packing room, they are conveyed down its length. When the various types of cartons of finished ware reach their respective sealing machines, they are shifted to an auxiliary conveyor line which carries them directly into the sealing machine. After sealing, the cartons are piled onto skids. In the case of a carton which does not require sealing, it is manually removed from the conveyor line and transferred to skids. The skids, when filled to their capacity, are picked up by a Clarkette pull tractor and taken to either the ware sheds

Fig. 4. View of the charging end and the furnace platform, showing also the monorail system for handling batch.

Fig. 5. The new packing room, with the exit end of the lehrs toward the camera and showing the carton conveyor. The latter is believed to be the longest belt conveyor in a glass factory.

Fig. 6. Gentral view of the carton sealing room.

or directly to the loading platform. A general view of the sealing room showing a sealing machine in the foreground and the type of skids used is shown in Figure 6. One part of this room is occupied by the prescription ware department, where the various styles of prescription ware are capped and packaged for the prescription trade.

To dispose of the cullet from the hot-end, long enclosed troughs, which run from the factory to the basement, convey the cullet by gravity from the machines and the feeders to a "V" shaped trough, the approximate dimensions of which are 5 ft. in width, 60 in. in length. and 4 ft. in depth. At the bottom of the trough is a motor driven screw conveyor which runs the entire length of the trough. An inlet for flow water is provided at the lower end of the trough. As the hot cullet from the forming machines and feeders drops into the water in the trough it is chilled and granulated and falls to the screw and is conveyed to the lower end of the trough. At this point an inclined screw conveyor picks up the granulated cullet and allows the excess water to drain back into the trough. This inclined screw conveyor then feeds the water-drained granulated cullet into a truck. The conveying equipment used in this system was supplied by Link-Belt. Both the "D" and "E" furnaces are equipped with this type of cullet disposal system. An overall view taken from the exit end of the cullet system under the "D" furnace is shown in Figure 7.

Also located in the factory basement are six Buffalo Forge, type SL, size 6 blowers, which are used to supply air for cooling the mould equipment on the forming machines. The three blowers used for supplving the mould cooling air to the "D" furnace are shown in Figure 8.

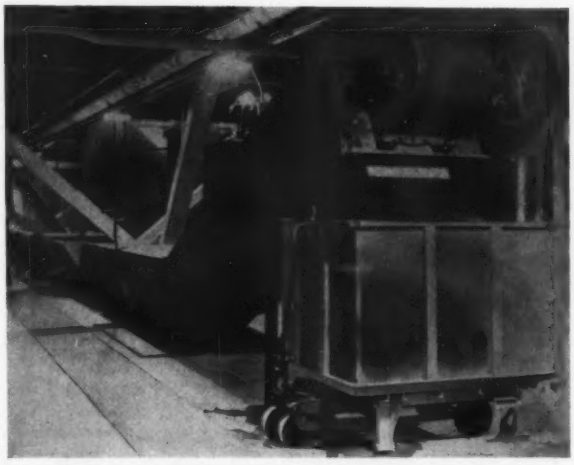


Fig. 7. The hot-end cullet disposal system, taken from the exit end. The factory is equipped with two of these large tanks.

Fig. 8. Blowers which supply mold-cooling air to "B" factory.

SCREEN COLOR MIXING METHODS

By VICTOR H. REMINGTON
B. F. Drakenfeld & Co., Inc.

The screen process has become a very important method of decorating ceramic products during the past few years. As the quality of the finished work depends largely upon conditions of the paste-color used, an examination of the various mixing methods employed is of value.

The actual operation of color grinding is the work of the color manufacturer, who grinds his product so that it will pass through a 325 mesh screen. It is this resultant impalpable powder which must be converted into a smooth, grain free paste before it can be used in the screen process. Generally the operation of converting powder to paste is referred to as a color grinding process. In reality, it is not an act of grinding but rather one of thorough mixing; that is, reducing the size of the color aggregates and coating each individual particle with a film of oil.

It is not difficult to visualize the result of pouring a quantity of oil into a given amount of powder and stirring the resultant mixture with a paddle. No matter how long the stirring is continued, one would expect to find small lumps of color present. The outside surfaces of these aggregates would be wet with oil, and this oil would rapidly diminish in quantity as the center of the particle is approached. Employing the best mechanical means, these particles can be smoothed out and reduced to sizes not discernible in the completely fired print.

Iron Color Mills

In the early days of hand decorating, fifty years or more ago, it was generally the job of a decorator's apprentice to grind the color in a suitable oil on a glass plate by means of a heavy glass or stone muller (Fig. 1). It was not unusual to spend as much as eight to ten hours on a pound of color. Later, the hand operated iron paint mill was adopted for mixing operations, though it proved to be of little value as a grinding unit. For many years, the iron color mill without appreciable improvement had been used in mixing ceramic colors; so it was quite natural that it was the first machine selected to mix screen color paste. On account of the rather heavy consistency of screen paste, especially that required for metal mesh screens, the three-legged iron mill has been replaced in a great many instances with mills of four legs, and more sturdy all around construction.

Fig. 1. Grinding color on glass slab using glass muller.

Fig. 2. Iron color mills.

Figure 2 illustrates a battery of these iron mills. Machine-cut gears aid materially in providing a smooth flow of power to the grinding surfaces. If these surfaces, the upper on the hopper and the lower on the nut, are machined to an accurate fit and reground when worn, the iron mill will give good performance. The six-inch mill with a one-gallon hopper is the size most generally used.

The limited capacity of the iron mill has been a distinct handicap. The tendency of many operators to loosen the grinding adjustment so that the color flows through the mill at a faster rate usually results in color paste which is not as smooth as it should or could be. For best results, the color paste should be first rough ground by passing it through the mill with a loose grinding adjustment. A rate of twenty minutes to one-half hour per gallon is about right. The grinding adjustment is then tightened and the color passed through the mill a second time. It is in this second milling that patience is required and the mill so regulated that approximately three and one-half to four hours are required to mix a gallon of color. In other words, the grinding surfaces should be set as close as possible without showing any appreciable amount of grey iron contamination from the wearing surfaces. Starting with a cold mill, it will be necessary to loosen the tension from time to time as the heat

developed through friction tightens the mill. With the proper setting, a six-inch mill has a capacity of five to six pounds of color paste per hour.

The Colloid Mill

During the past few years, the colloid mill has come in for a good deal of attention as the "ideal" grinding unit for paste color. Although some decorating departments still look upon this machine as being entirely satisfactory, there are those who have been distinctly disappointed in its performance.

Colors, glazes and enamels of ceramic type are by their very nature quite abrasive. By necessity and principle, the colloids mill is a high-speed machine, and even though the wearing surfaces are coated with wear resistant alloys, they eventually wear to a somewhat elliptical shape, though it may be ever so slight. Thus, if the mill is adjusted to a clearance of say .003 inches minimum, the maximum clearance may be as much as .007 inches.

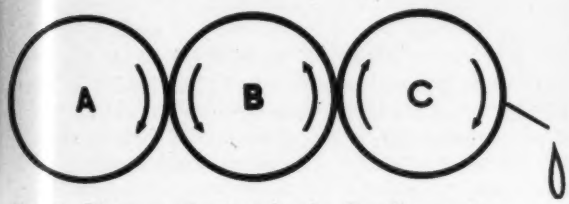


Fig. 3. Diagram of principle of roll mill operation.

Although the mill is water cooled, the color paste is frequently heated through friction to as high as 240° Fahrenheit in grinding. Since this temperature is sufficiently high to volatilize some of the lighter boiling constituents of most squeegee oils, some provision must be made to exhaust the fumes from the color preparation room.

In order to satisfactorily handle the heavier types of paste frequently required in metal screen printing, it is advisable to power the mills with larger motors than those which the manufacturers ordinarily recommend for lighter liquids. Operating at a high rate of speed, a good, solid, preferably concrete, foundation should be provided for the colloid mill.

Roll Paint Mill

Vitrifiable enamels in paste form are not unlike ordinary paints in many respects. In fact, most bottle decorating departments refer to the mixed enamels as "paints." Therefore, it would seem logical to assume that some of the standard paint milling equipment of proven performance should, likewise, serve equally well with "ceramic paints." Accordingly, three and five-roll paint mills were investigated, and when it was found that the same were operating successfully grinding silica paint, it was felt that grinding vitrifiable enamels would present no new problem to roll mill manufacturers.

The principle of operation of a roll mill is indicated in Figure 3. Rolls A, B, and C revolve as indicated by the arrows. Unground color is drawn between rolls A and B; but because roll B is rotating faster than roll A, a very definite grinding, rubbing and smoothing action takes place. Some of the color adhering to roll B is carried around to point of contact with roll C. Here again, because of greater RPM of roll C a further grinding action takes place. Also because of the faster speed of the last roll, most of the color is transferred to it to be later scraped off and discharged into a receiving container. Usually, one pass through the mill is sufficient to remove the last trace of coarse particles and provide thorough mixing.

Fig. 4. Three roll 5″ x 12″ paint mill. Front and back rolls are adjustable. All are water cooled.

A mill having three 5″ x 12″ rolls has a capacity of approximately 100 pounds of color paste per hour. The machine is not difficult to clean and changing color does not present a serious problem.

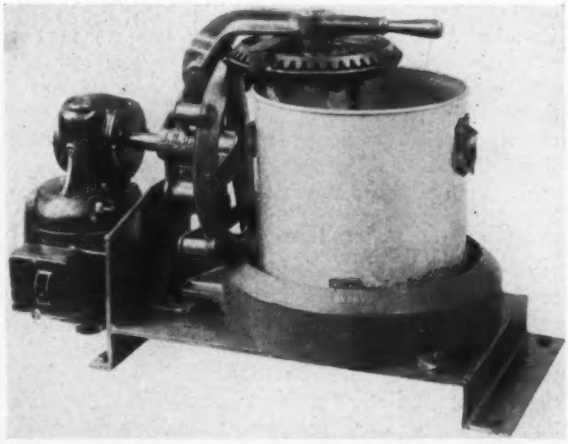


Fig. 5. Pony mixer. Produces thorough pre-mixing of color and oil.

The rolls are made of highest quality hardened steel and one machine which has ground 50,000 pounds of paste shows very little evidence of wear. When the rolls do require refinishing, they should be returned to the manufacturers of the machine for honing. Except on the very small laboratory mills, the rolls are water cooled. This is a desirable feature for it prevents the color from becoming heated and aids in the grinding of some products which otherwise might not transfer well from one roll to another if heated by friction. There being no waiting for the mixed material to cool to room temperature, the color may be used immediately.

On account of the general all around efficiency of a roll mill, the unit is recommended to the decorating department desiring the best method of color paste preparation.

One phase of the color paste handling which is so often neglected, or else poorly attended to, is the preliminary mixing of the dry color and squeegee oils. The more intimately the oil is incorporated into the color before being placed in the mill, the better will be the finished results. This is especially true with both colloid and roll mills. An oil-coated particle is much less abrasive than small lumps of dry powder. For the lack of a better method, the operator would do well to place the two ingredients in a round pan and stir well until all traces of dry color have disappeared.

Pony Mixer

A pony mixer has proven to be an ideal machine for the preliminary mixing operation. So well does it knead the powder and oil together, the operator can easily judge what the final viscosity of the finished ground paste will be by the appearance of the same in the mixing container. The machine is not difficult to clean. This is especially true if the container and mixing blades are of stainless steel.

RECENT BOOKS

The Chemical Action of Ultraviolet Rays, by Carleton Ellis and Alfred A. Wells, revised by Francis F. Heyroth. The common need of workers in theoretical and industrial chemistry, biology and medicine for a modern reference work on photochemistry has led to the preparation of this revision of the familiar work of Ellis and Wells, "The Chemical Action of Ultraviolet Rays." Recent theoretical advances have so altered the interpretation of many reactions as to require the rewriting of a large portion of the text. Incorporation of the results of the great recent activity in this field has necessitated considerable expansion. Certain explanatory chapters regarding the modern viewpoint have been added for readers who may not have had the advantage of recent advanced courses in physical chemistry. These chapters are intended to convey in non-mathematical fashion an understanding of the manner in which certain wave-lengths may supply the activation energies of chemical reactions. Part I deals with the sources of ultraviolet radiations; Part II, the photochemical processes; Part III, applications of photochemistry to industrial products, and Part IV, applications of ultraviolet rays in biology. The price of the single copy is $12.00 and may be secured through THE GLASS INDUSTRY.

A Key to Pottery and Glass, by Bernard Rackham. The author, former curator of the ceramics department of the Victoria and Albert Museum in London, traces the history of the art of ceramics. The first part of the book deals with pottery, describing its origins in Egypt, the history of its manufacture and development in Greece and Rome, and the subsequent Europeon tradition. It traces the history and influence of the potter's art in China and the Near East, of the specialist wares such as Maiolica, Faience and Delft, and concludes with a section dealing with modern times. Part II is devoted to glass; shows how the influence of glass-blowing revolutionized manufacture, examines the history of stained glass through the Near East and Venice, and discusses the manufacture of glass of the present day. The book may be purchased for $2.25 from THE GLASS INDUSTRY.

THOMAS A. KIMES

Thomas A. Kimes, co-publisher of "The National Glass Budget," died March 8 at his home in Pittsburgh more than two years after suffering the first of three strokes.

Born in Murrinsville, Pa., he attended public school near there. After his graduation from Grove City College, he became principal of the public school at Wheatland, Pa. He then moved to New Castle and was associated with the school system there, first as principal of one of the schools and later as superintendent of schools. In 1919 Mr. Kimes became associated with his brother Mr. A. W. Kimes in the publication of the "National Glass Budget" and since then had been its secretary.

A. K. WOOD NEW McKEE PRESIDENT

Mr. A. K. Wood, on March 10, was elected president of the McKee Glass Company, Jeannette, Pa., as the successor to the late Donald M. Smith who died on February 26, 1941. Mr. Wood prior to his elevation to the presidency, was vice president and factory superintendent of McKee.

At the meeting of the directors, William A. Wood, former production manager, was elected vice president. George D. Sailer, secretary, retains that post and that of sales manager, and D. B. Pilkey continues as treasurer and purchasing agent. M. A. Smith II, was made assistant secretary. The board of directors includes the new president, secretary and the treasurer, Mrs. M. A. Smith and Mrs. D. M. Smith.

PITTSBURGH AWARD TO DR. SILVERMAN

Dr. Alexander Silverman, head of the Department of Chemistry at the University of Pittsburgh, received the 1940 Pittsburgh Award of the Pittsburgh Section of the American Chemical Society at a dinner at the University Club, Pittsburgh, March 20. The award was given for "outstanding service to the profession of chemical education and for distinguished contributions to industrial chemistry and the ceramic industries."

Professor William L. Evans of Ohio State University and president of the American Chemical Society was among the speakers, who also included Dr. E. W. Weidlein, director of the Mellon Institute, Chancellor John G. Bowman of the University of Pittsburgh, and Dr. Ross C. Purdy, secretary of the American Ceramic Society. Dr. Adelbert W. Harvey, Fellow in the Mellon Institute, was toastmaster.

BASIC BRICK VS DESIGN IN CHECKER BRICK EFFICIENCY

By CHESTER E. GRIGSBY
General Refractories Company

Operators of regenerative glass furnaces, in common with other users of this type of furnace, have always been interested in increasing the efficiency of regeneration. In the glass industry attempts to increase the efficiency of the regenerators for the most part have, followed two general lines, namely, search for a superior refractory material and use of special designs and methods of setting.

In the days before furnaces were pushed for production at modern ratings, fireclay, or in some cases silica brick, in rectangular shapes were fairly satisfactory as glass tank checker brick. Even under those conditions, high alumina brick were occasionally tried, but did not find general success. More recently super-duty fireclay brick have proved economical in certain instances due to their superior resistance to slag and high temperature. As furnaces became operated at still higher capacity, high alumina and other special refractories were tried for very severe service conditions. While these improved service, they were not entirely satisfactory.

This experience eventually indicated that such special non-basic refractory materials in rectangular shapes were not completely satisfactory for severe operating conditions. This was due to the fact that the material of which they were made, in some cases, became sufficiently soft and sticky at top checker temperatures to trap the dry carry-over in much the same manner that a fly is trapped on fly paper. Once the batch dust was deposited on the brick, a wetted surface was created, trapping more carry-over. Thus the brick either slagged away, clogging the flues below and losing its own volume and heat capacity, or they built out directly into the flues, causing clogging. Either condition meant a waste of fuel and inefficient regeneration and required hot repairs and replacements.

Special Checker Shapes and Systems

Prior to the time that it became generally agreed that non-basic materials in rectangular shapes were not completely satisfactory for efficient checker operation, there were some attempts made with checkers made of non-basic materials of special design. Glass furnace operators are familiar, of course, with the numerous special shapes and methods of setting which have been developed. Many of these designs have been very effective mechanically, giving increased turbulence, means for cleaning, more rigid settings and increased ratios of effective surface to volume. Some of these designs gave improved efficiency with non-basic material (in some cases even with ordinary fireclay brick) as long as the brick remained full size and uncoated; others, which had special provisions for removing material from clogged flues, could be kept clean longer and with less effort. These gave improved life and efficiency compared with ordinary straight brick. As service requirements became more rigid, however, it was found advantageous to make these checkers of special materials in the silica, alumina and alumina-silica field. Here again the materials which had been tried with rectangular shapes were tried in the special shapes. Eventually the whole field of fireclay, silica, super-duty fireclay, high alumina and brick, as well as other special non-basic materials, were tried in the special shapes. These combined improvements in material, design and methods of setting, gave further good results.

However, experience obtained in recent years with furnace operated at high percent of capacity, has created a growing conviction among designers, refractories producers, and operators that special design alone could not overcome all of the shortcomings of materials of improper composition. No matter how good the design, it was usually found that the non-basic material of which the checker brick were made was not of the right type to permit them to always function as originally intended. This was true because, in spite of all efforts to accomplish the result, they would neither remain free of coating nor full size throughout the furnace campaign. The limitations of these designs were further evidenced by the fact that many of the designers featured special provisions to facilitate cleaning of flues.

In general, therefore, it has been found that special designs in non-basic materials are limited to such an extent by the materials of which they are made that they have not proved to be the solution to the more severe cases of checker trouble.

Fig 1. (Left) Three brick, all 9″ straights originally, after eight months' service on the top course of an air checker. The brick, left to right, are Ritex, high heat duty fireclay, and moderate heat duty fireclay.

Fig. 2. These brick have been in service one year on the top course of a glass tank checker chamber. The brick left to right in groups of two, one above the other, are 60 per cent alumina, Ritex, and burned magnesite, with super-duty fireclay brick on bottom right and dense dry press high heat duty fireclay brick at the top right.

Fig. 3. This shows Ritex and super-duty fireclay brick after one year on the top course of a checker chamber in a glass tank. The two brick at the left were subjected to the same conditions under the drip from the uptakes. The two brick at the right were not under the drip.

Fig. 4. This shows a comparison of Ritex, in the two center rows, with super-duty fireclay brick in outer rows after a year on the top course of a glass tank checker chamber.

Basic Refractories

In view of the difficulties of getting a satisfactory non-basic checker brick, with or without special design or methods of setting, the superior chemical properties of refractories in the basic field—magnesite and chrome—were fully considered long ago. Tests to determine the possibilities of using this type of material for checker brick were based on two important fundamental advantages which basic brick possess for glass-tank checkers. The early tests on burned basic brick and later tests on chemically bonded basic brick have shown, as expected, that the composition of this type of brick causes them to give the following results, even in the most severe section of top checkers:

First: Basic brick are so resistant to high temperature that they are dry and not soft or sticky in any part of a checker chamber. As shown in Fig. 5 and Fig. 8, the carry-over is also dry and easy to crumble. Furthermore, mixtures of basic brick and carry-over have very much higher melting points than compounds and eutectics of the same carry-over with non-basic refractories. The action of batch dust on basic brick, therefore, is quite similar to the action of dry snow on a dry surface; i.e., there is no wetting and therefore no sticking. The batch dust, consequently, passes by the basic brick and eventually out of the checker chamber. Thus the basic brick do not melt or erode from slag action or lose volume in any way. Neither do they accumulate a coating or cause clogging. They therefore remain full size, clean and efficient throughout the run without cleaning or hot repairs.

Second: Basic brick have 30 to 50 per cent more heat capacity than fireclay brick. Thus a basic brick having the proper physical properties is practically an ideal checker brick for glass tank furnaces.

Burned Basic Brick

In spite of the advantages given above for basic brick in general, the conventional burned basic brick cannot be used for glass tank checker brick because of physical shortcomings, particularly low resistance to temperature changes. The effect of this low resistance to thermal shock is well illustrated in Fig. 2. This picture shows spalling which is typical of burned chrome or burned magnesite brick after service in a glass tank checker chamber. Even the best burned basic brick spall in a few weeks, similar to the brick in the third group from the left in Fig. 2.

Thus there was a long period when basic brick could not be used as glass tank checker brick in spite of their desirable chemical properties, because the only brick available were the burned products which would not stand the thermal shock. This low spalling resistance of burned basic brick, however, had stimulated attempts to produce a basic brick with more satisfactory physical properties.

The Ritex Process

As a result of the need for a better basic brick, the RITEX process was developed, and in 1928 an improved chemically bonded, basic brick, made by that process, was introduced. This patented process is characterized by three distinctive features:

(1) The use of "gap-sizing," the type of particle control in which there is a gap produced in a continuous grading by the removal of particles of intermediate size.

(2) The formation of the brick under very high pressure (10,000 pounds per square inch).

(3) The bonding of the formed brick without kiln firing by the use of highly refractory bonding agents.

These refractories have a unique combination of the following desirable properties: high density, excellent spalling resistance and high hot load strength. They also have unusual resistance to chemical attack, vitrification, and shrinkage at the highest temperatures obtained in service.

Early Tests with Improved Basic Brick

Because of the unusual properties of these improved basic brick, they were tried in 1933 for service in glass tank checkers. The results of this test after eight months service are shown in Fig. 1 taken in 1934. The results of another test in a tank making a different type of glass are shown in Figs. 2, 3 and 4 taken in 1935. This latter test included practically every type of refractory on the market. The brick shown in the photographs had given a record run—for this plant—of one year. These tests were made because then, as now, erosion or clogging of checker brick often resulted in checkers forming the "bottle neck" of the tank as far as refractories were concerned.

While the above two tests and other early tests were successful, others were not so successful because the chemically bonded basic brick were at that time installed only on the top course. In certain cases the high heat duty fireclay brick directly below the basic test brick became so thin from slag erosion that they would not support the weight of the basic brick or any other

brick above them. This type of installation occasionally led to the conclusion that the improved basic brick were not satisfactory. It was learned later, however, that in order to get the correct conclusion, it was necessary to install the brick deep enough to get below the point where any serious erosion occurred on the fireclay brick. This improved testing method, which insured mechanical support for the basic material, resulted in successful installations where early tests were considered unsuccessful for the reasons noted above.

Wherever the unburned basic material was properly used, the recorded results—even in the early days with mixtures made for metallurgical purposes—indicated that even without the use of special shapes, very efficient checker operation was obtained. By a combination of the improved basic material with some of the better special designs and methods of setting which have mechanical advantages of themselves, still more efficient results might be obtained. In any case, this material for the past several years has been the answer to many cases of severe operating conditions in glass tank furnaces. Because of this superiority of the basic material, some operators started regular use of these brick as early as 1935. Through the courtesy of these early users. extensive field data were obtained in the first four years. These data led to experimental work which resulted in changes in certain properties of the early metallurgical brick.

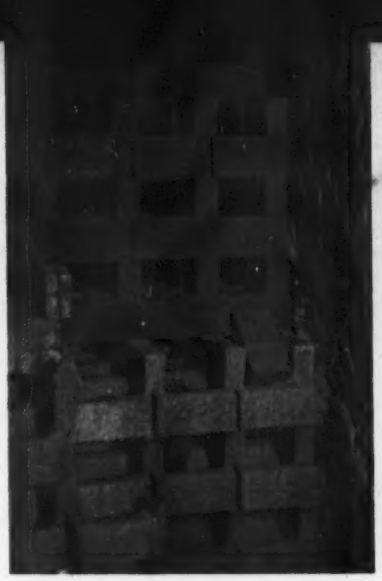


Fig 5. This shows eight courses of Ritex brick after one year's service under No. 1 port in a bottle glass furnace. The dust accumulation of carry-over can be seen on the brick at the top left of the photograph. The brick below the Ritex are high heat duty fireclay.

Laboratory and Field Development Work

In 1938 a research program was initiated to develop mixtures with properties particularly suited to requirements in glass tank checkers. Following an extensive laboratory investigation, a more thorough study of field conditions was begun. This program has resulted in development of mixtures whose properties are quite different from those of any other brick ever developed. The most notable result of this work was a special mix with much greater resistance to certain types of carry-over than anything previously available.

Figs. 5, 6, 7 and 8 taken in 1940 show the excellent condition of these brick after one year's service in a bottle glass furnace. These brick have been used in this furnace regularly since 1935. The first installation at this plant was successful because the checkers remained full size and clean and flues open all the way down. This result was accomplished in spite of heavier charges. Fuel consumption was, therefore, reduced and cleaning was eliminated. High heat duty fireclay brick, on the other hand, in the course directly below the basic brick eroded away to about ¾ in. in thickness. In looking at Fig. 5 several operators have been under the impression that this was a new installation until they were told differently.

Fig. 9 shows a comparison of high heat duty fireclay brick with RITEX after one year in another bottle glass furnace. The cross section of both brick was originally the same as that of the unused brick shown in the center of the picture. The brick at the left is high heat duty fireclay from No. 2 port. The brick at the right is RITEX from No. 1 port. Both brick were directly underneath the corrosive drip from the uptakes. The fireclay brick has lost about one-half of its original weight. RITEX has remained full size. The slag from the fireclay brick has flowed down and naturally caused clogging of flues in the courses below. The available heat capacity of the fireclay brick after service is only about one-third of that of the RITEX.

Present Status

While it is generally admitted that a good checker brick should have high heat capacity, there is considerable difference of opinion as to just how high this heat capacity must be in order to give maximum fuel efficiency. It has been noted that basic brick have 30 to 50 per cent more heat capacity than fireclay brick. This difference can be calculated or it can be demonstrated by test.

Some designers have expressed interest in this property of the basic material and are considering the use of these brick throughout the checker chamber in order to increase furnace efficiency. Regardless of the importance of heat capacity, there is general agreement regarding the necessity of keeping checkers clean and full size and flues open, in order to avoid waste of fuel. The fuel savings noted with these chemically bonded, unburned basic brick are doubtless due mainly to the fact that these brick meet these latter requirements to a remarkable degree without cleaning and with regular rectangular shapes.

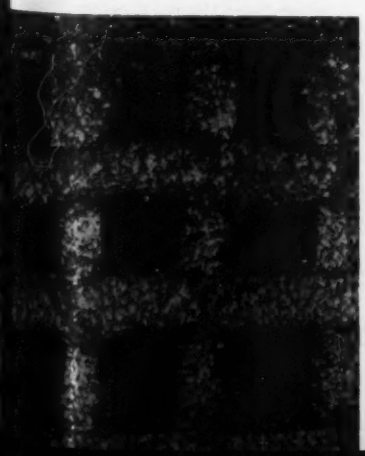


Fig. 6. This is a view taken from a position in the uptakes looking directly down into the vertical flues under No. 2 port. It will be noted that the brick have less accumulation of the loose carry-over than the brick under No. 1 port. As can be seen, the brick are clean and there is not clogging at any point. This is a top view of the brick in Fig. 5 after one year's service.

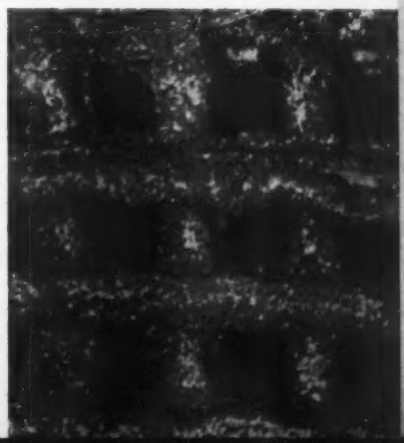


Fig. 7. This view was taken from the uptakes looking down into the flues under No. 1 port. The increase in the amount of loose dusty carry-over on the top of the brick as compared to No. 2 port (Fig. 6) can be noted, but it can also be seen that the flues are open. These brick also have been in service a year in the same furnace as those in Figs. 5 and 6.

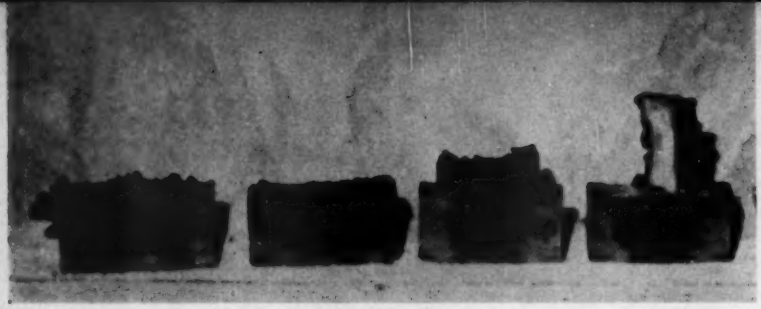


Fig. 8. This shows four brick from the top course of the furnace shown in Figs. 5, 6 and 7. The left brick is from the top longitudinal course with the carry-over in place. This brick was not directly under the port opening. Brick No. 2 from the left is similar to No. 1, but with the carry-over removed. Brick No. 3 and No. 4 are from the top cross course. No. 3 has the carry-over in place; No. 4 shows it stood on end. This carry-over is dry and dusty, showing that the material carried over from the batch is not molten at top checker temperatures.

Use of these unburned basic brick is recommended for any desired depth. They have been used successfully to depths varying from 3 to 8 feet and can be used throughout the chamber if desired. The general rule is to use these brick to a sufficient depth to insure against their being let down by erosion of the clay brick below. Usually, the basic brick are used to a greater depth under the ports having most severe conditions and are used to a reduced depth, as needed, under ports where conditions are less severe.

Due to their extremely high resistance to spalling, they can be used in safety for hot repairs without any fear of decrease in service due to thermal shock. As a matter of fact, several operators have even tested them with good results by opening the rear wall at the end of the checker chamber and inserting the cold brick into the chamber at full heat.

These special basic brick have been used for about six years to meet severe checker problems in several plants making building glass and bottle glass. They also show promises in certain cases of special glass where conditions are very severe. It has been found that most furnaces, operated at four to eight square feet of melting area per ton of glass, are in need of an improved checker brick for their most severe sections.

In order to fully explain the reasons for the success of basic brick having the special physical properties of RITEX it is desired to call attention to the condition of the clay brick below the basic brick when the latter are installed to the proper depth.

It has been pointed out that the basic brick themselves above the high heat duty fireclay brick remain clean because they do not pick up carry-over or cause build-up in the fluees. Neither do they melt away, erode from slag action, or in any other way lose volume. They, therefore, contribute no material to the flues below which could cause clogging. When the RITEX are used to the proper depth, the high heat duty fireclay brick on which they are set, are below the temperature at which they are soft enough either to trap the dry carry-over or form fusible compounds with the batch dust. Since these fireclay brick below the improved basic brick form no direct combination with the carry-over and there is nothing carried down from the improved basic checkers above, all the checker brick remain clean and full size and retains practically full original efficiency throughout the run without expensive cleaning or hot repairs. This chemically bonded basic material, with or without special design, seems to provide a real solution to present severe glass tank checker troubles.

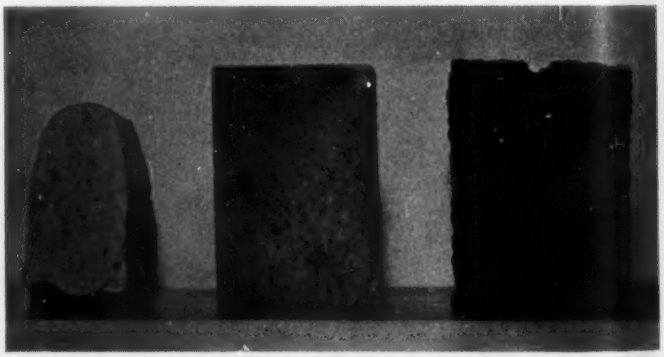


Fig. 9. This shows a comparison of high heat duty brick from No. 2 port at the left, with Ritex from No. 1 port at the right, after one year in another bottle glass furnace. Both brick were originally the same size as the unused brick shown in the center of the picture. Both brick were directly underneath the corrosive drip from the uptakes. The fireclay brick has lost about one-half of its original weight. Ritex has remained full size.

AUDITS FOR CREDIT PURPOSES

In the belief that statements prepared for credit purposes should be based on audits whose scope should be more precisely defined, the New York Credit Men's Association has prepared a booklet: "Financial Statements—Minimum Requirements for Credit Purposes." This contains among other things a series of commentaries on important balance sheet items, to be used as an integral part of the balance sheet, applicable to all industries.

The Association recognizes that investors are not always analysts, and for such purposes a short form of report may be adequate. For the granting of credit, however, it believes that a detailed statement of just what was done in connection with the audit, is essential; a blanket expression of opinion is not sufficient. The commentaries require, for example, that cash be confirmed by direct communication with the client's bank; that accounts receivable be analyzed as to age in order to determine their collectibility, and so on.

The New York Credit Men's Association is located at 354 Fourth Avenue, New York.

• Lieutenant A. K. Porter of the Corning Glass Works has been ordered into active service. He has been assigned to Company C, 3rd Battalion, at the Engineer Replacement Center at Fort Belvoir, Va.

VANADIUM AND CHROMIUM OXIDES IN REFRACTORIES AS AIDS IN THE ELIMINATION OF CORDS IN GLASS

By A. E. BADGER and H. R. PINNOW*

In recent years the prevention of cords and waves in commercial glass has received considerable study due not only to the objectionable optical effects produced by these inclusions in glassware but also to their deleterious influence on the mechanical strength of the ware.

The important role which surface tension plays in the rate of disappearance of cords and the production of homogeneous glass has been pointed out by several investigators.[1] An extensive series of measurements of the surface tension of various glasses has also appeared in the literature.[2]

One source of cords in glass is the corrosion of refractories by the molten glass, which gives rise to cords having a different chemical composition than that of the main body of glass. It has been shown[1] that cords which possess a greater surface tension than that of the surrounding glass tend to have a small surface of contact; hence the diffusion processes which produce homogeneous glass are hindered and the cords tend to persist. Conversely, if cords have a smaller surface tension than that of the glass which surrounds them, the cords tend to spread out and present a larger contact area, with the result that the homogenizing process is accelerated.

It has been found[2] that the addition of certain oxides to a soda-lime-silica glass produces a marked lowering of the surface tension of the resulting glass. Contemplation of this fact results in the suggestion: Why not incorporate such oxides in refractories so that solution of the latter in the molten glass will produce cords of lower surface tension than that of the main body of glass? Such cords would disappear more rapidly than those resulting from corrosion of the usual refractories.

Among the oxides which tend to lower the surface tension of glass[2] are the alkalies, lead oxide, boric oxide, vanadium oxide, and chromic oxide. Eliminating the strong fluxes from this list leaves the oxides of vanadium and chromium as suitable materials for trial. Accordingly a series of experiments has been made to determine the feasibility of using these oxides in glassmaking refractories as an aid to the elimination of cords. Among these experiments the following are noteworthy.

Experiment 1

Three porcelain crucibles, about 1½ inches in height, were nearly filled with powdered soda-lime-silica glass In one of these crucibles a small fragment (roughly ⅛ inch across) of a glass containing about 7.5 per cent vanadium oxide was pressed about ⅛ inch beneath the surface of the glass powder; in the second crucible a glass fragment containing chromium oxide was similarly placed, while the third crucible contained a fragment of a glass containing about 6.3 per cent cobalt oxide.[3] The three crucibles were then heated together in an electric furnace at about 1100° C. for a period of one-half hour, after which they were removed and cracked open.

Since the surface tension of the vanadium-bearing glass (ca. 235 dynes per cm. at 1200° C.) and that of the chrome glass (ca. 250 dynes per cm.) were considerably lower than that of the surrounding soda-lime glass (ca. 300 dynes per cm.), while that of the cobalt glass was greater (ca. 314 dynes per cm.), it would be expected that the vanadium and chrome tests would differ sharply from the cobalt test.

Figure 1 shows this assumption to be correct. The vanadium and chromium glasses have spread over the surface of the glass in a similar fashion as oil on water, while the cobalt glass exists in discrete spots embedded in the surrounding glass.

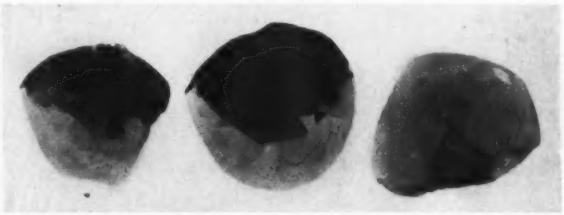
Experiment 2

As a check on the results of the first experiment, similar small crucibles were filled with soda-lime-silica glass and allowed to fine at 1250° C. Small fragments of the vanadium glass and of the cobalt glass were then dropped on the surface of the molten glass and the heating continued for various periods. The crucibles were then removed and cut with a diamond saw in order to observe the interior.

Figure 2 shows these results. After a 5-minute period the vanadium glass (of low surface tension) has already spread over the surface while the cobalt glass (of high surface tension) has formed a ball which is sinking slowly through the molten glass. Continued heating of the samples permitted the cobalt glass to sink to the bottom of the crucible while the vanadium glass remained on the surface.[4]

Experiment 3

Experiments 1 and 2 served to illustrate the pronounced effect of surface tension on the behavior of molten glasses. Preliminary trials dealing with the elimina-



a b c

Fig. 1. Contrasting surface tension effects. (a) A small fragment of glass of low surface tension containing vanadium tends to spread over the surface of soda-lime glass. (b) Similar effect of chromium glass on surface. (c) A fragment of cobalt-bearing glass of high surface tension has the tendency to ball up. (Figures (a) and (b) were photographed with ultraviolet light to show vanadium glass film by fluorescent effect.)

*Department of Ceramic Engineering, Eng. Expt. Station, University of Illinois, Urbana, Illinois.

Left: Vanadium glass.

Below: Cobalt glass.

5 min. 25 min. 50 min. 22 hrs.

Fig. 2. Contrasting surface tension effects of fragments of vanadium glass (low surface tension) and of cobalt glass (high surface tension) placed on surface of molten glass at 1250° C for various periods as noted on the figure. Vanadium glass spreads over the surface while cobalt glass remains distinct. (Vanadium glasses photographed in ultraviolet light; cobalt glasses in ordinary light.)

tion of cords from refractories were then made. For these experiments three test rods, about ⅜ inch square and 3 inches long, were made using 90 parts of Mississippi pot clay + 10 parts of either vanadium oxide (V_2O_5), chromium oxide (Cr_2O_3), or cobalt oxide (Co_3O_4). These refractory rods were fired and then placed in a vertical position in three platinum crucibles. Powdered soda-lime-silica glass was packed around the rods and the set of crucibles then heated at about 1250° C. for eight hours to permit corrosion of the rods by the glass. The rods were then removed and the molten glass poured in molds. The glass samples were then ground and polished.

Figure 3 shows the glasses resulting from the vanadium and cobalt tests. The glass which attacked the vanadium-bearing refractory contains diffuse clouds of vanadium glass; the glass which was in contact with the chromium-bearing refractory was colorless and quite free from cords; the cobalt glass cords were sharp and distinct.

A similar set of results was obtained from melts made in refractory pots containing vanadium, chromium, or cobalt oxide.

Conclusions

The above experiments indicate the desirability of incorporating certain oxides in glassmaking refractories which will lower the surface tension of cords resulting from the corrosion of the refractories by the metal. Some encouraging results have been obtained using vanadium and chromium oxides for this purpose.

Obvious requirements for any oxide which may be added to glassmaking refractories for the purpose of reducing the surface tension of cords formed by corrosion are (a) that the fusion temperature of the refractory be lowered only slightly by the addition of the oxide, (b) that the rate of solution of the refractory mixture not be excessive, and (c) that the cords be colorless or nearly so.

In regard to Part (a), fusion tests showed that 10 per cent of vanadium oxide reduced the fusion temperature of Mississippi pot clay from Cone 30 (ca. 1650° C.) to Cone 27 (ca. 1605° C.). The presence of 20 per cent chromium oxide raised the fusion temperature to Cone 31 (ca. 1680° C.). Concerning Parts (b) and (c), only qualitative evidence is available at present. Glasses which were melted in refractory pots containing vanadium oxide had a light green color which indicated considerable solution of the refractory in the glass. Glasses melted in pots containing chromium oxide were colorless, except for a slight fringe of green at the metal line. The colorless state of the glass indicated great resistance to corrosion of this refractory.

Additional experimental work is necessary to determine the optimum additions of vanadium or chromium oxide to refractories, as regards freedom from cords, small attack on refractories, and consequent freedom from color. The application to commercial manufacture would appear to be most favorable in the melting of glasses in which a light green color is not objectionable.

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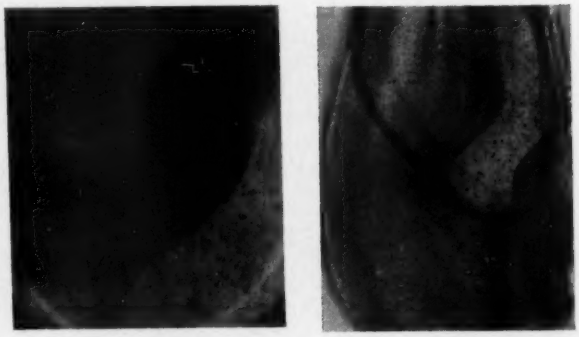
[1]For example, see "Remarks on the Influence of Surface Tension in Glass Melting Processes" by H. Jebsen-Marwedel: J. Soc. Glass Tech., Trans. 21, 436 (1937) and "The Effect of Surface Tension on the Formation of Cords" by W. B. Silverman, as presented before the Glass Division, American Ceramic Society, Autumn Meeting, 1940.

[2]Reference may be made to the following publications: C. W. Parmelee and K. C. Lyon: J. Soc. Glass Tech., Trans. 21, 44 (1937); C. W. Parmelee and C. G. Harman: J. Am. Ceram. Soc. 20, 224 (1937); A. E. Badger, C. W. Parmelee, and A. E. Williams: J. Am. Ceram. Soc. 20, 325 (1937).

[3]These fragments were taken from glasses used in previous studies of surface tension. See reference 2.

[4]The relative densities of the glasses of course affect the rate at which the fragments sink. The cobalt glass had a density of 2.61 gms. per c.c. at 20° C. and that of the vanadium glass was 2.52. The density of the surrounding soda-lime-silica glass was 2.51 gm. per c.c.



(a) Vanadium Glass (b) Cobalt Glass

Fig. 3. Glass melted in contact with refractories containing (a) vanadium oxide and (b) cobalt oxide. Cords of cobalt glass (high surface tension) tend to persist longer than do cords of vanadium glass which has lower surface tension. Chromium glass was quite free from cords and is not shown. (Ultraviolet light used for photographing vanadium glass; ordinary light for cobalt glass.)

ORGANIZATION OF RESEARCH DEPARTMENTS

By FRANK W. PRESTON

The various industries which are grouped together under the title of the "glass industry," though they have little in common, have not been very research conscious. They have not been entirely unprogressive, but the progress has come from a very few sources. Perhaps that is true of other industries, and indeed of the human race as a whole. Nonetheless, the signs now point to the necessity of the glass industry spending far more effort, and far more money, upon research than has been their practice in the past. In this respect again, there is nothing essentially different here from what is true of most other industries, if they want to survive at all.

We have passed the time when a rapidly expanding population called for a simple expansion of plant and multiplication of product with an assured market. This extensive cultivation of the field is not entirely at an end: common glass articles will continue to be made, perhaps in greater quantities than ever. But there will have to be refinement of the manufacturing processes, and probably of most of the products, in an age which is passing from a lax commercialism to a tense technology. Conservation of resources, whether of raw materials, some of which are not so plentiful as they were, or of effort, in view of the limitations on hours of work, rates of pay, and the innumerable taxes now assessed against payrolls, will demand much more scientific control than was necessary in the past.

But over and above scientific control, which in borderline cases may pass for scientific research, there is scientific research proper. The usual result of such research is the complete making-over of industry, a remaking sometimes so complete that it virtually amounts to exterminating an old industry and substituting a new one.

Sometimes the revolution occurs within the industry, and can employ the old personnel both of capital and labor; and sometimes it occurs with considerable displacement of both, when busses replace trolleys, or garage mechanics replace ostlers.

In view of the possibilities, both threats and opportunities, now obviously ahead, it may not be amiss to indicate some of the problems and procedures involved if firms in the industry decide to go scientific. It is not usually difficult to eestablish scientific controls, for what usually means merely applying existing knowledge to a particular plant. The result is not instantaneous, but it is usually fairly prompt, and often good. Scientific research is not so prompt, for it involves first discovering new knowledge, and then applying it, a slow process in comparison, but a very paying one in able hands.

Scientific Research is the most learned of all professions, and is far ahead of law, theology, or even medicine. There are very few men in the United States capable of doing even elementary research, and still fewer that are good at it. Only a few science and engineering graduates can do research. Therefore the industry should not imagine it can purchase a research establishment at full going order and expect to get immediate satisfaction, as they might from a new foreman or superintendent. They might just as well expect to transplant a giant redwood with the same case as they might move a dogwood.

This should not be taken as a discouragement. Redwoods in the wild are found in only a limited area of California and Oregon, but young ones have been transplanted and are growing vigorously now in London and New Zealand. In a couple of thousand years these countries may have the finest redwoods in the world.

Now the establishment of a profitable research department is not a matter of a thousand years, but normally it is a thousand days, or three years. That at any rate was what we used to figure twenty years ago. Sometimes results come far quicker, but this is no more normal than expecting a transplanted lilac to flower the first year.

In order to give some ideas of a practical nature about the organizing of research departments in industry, it seems convenient to take a hypothetical case. We assume that the company is in the glass container field and does ten million dollars worth of business a year. This is merely a round figure. We could compare it with the procedures for a one million dollar concern, which would be pretty small, or with a hundred million dollar, but that is somewhat larger than the largest in existence in this field. The intermediate figure of ten millions seems the most useful to make a "case history." The general argument would apply with little change to a firm doing three million dollars or thirty, or even outside these limits, so that it is applicable, with reservations, to a majority of the actual companies.

It should be clearly understood that what is here envisaged is a research department, not a control laboratory, or a "history and specifications" department. On the other hand, a development department whose work arises out of research, and not out of wild-cat inventing, might normally fall within the procedure outlined.

Proposal to Establish a Research Department for a Company Doing $10,000,000 a Year Business

1. What is said below is of somewhat general application. It does not follow that it should be followed rigidly in any particular instance or in any particular company. It assumes that the company is, generally speaking, sound; that it is not foolishly overcapitalized, or cruelly undercapitalized; that it is reasonably well managed, and solvent, and that it is not in an industry that is on its way out. It assumes that the industry, and the particular company, has possibilities of growth; and that we desire a healthy growth, not a mushroom spurt, and so are considering a somewhat generalized plan for long-term development.

2. We confine ourselves to what may be broadly termed technical research, eschewing such subjects as "market research." The subject matter is mechanics, physics, chemistry, and perhaps a little biology. It is not psychology.

3. Dr. C. E. Mees, head of Kodak Park, laid down the view many years ago that a progressive company can well afford to spend 1 per cent of its gross turnover for research. In the case of our hypothetical company, this

is $100,000 a year. Such an amount of money, if handled wisely, will enable the company to grow and then 1 per cent of the annual turnover will be more than $100,000.[1]

4. The glass container industry does about $150,000,000 of business a year, so it ought on the above basis to spend 1½ millions on research.[2] The probability is that it does not spend anything like this. A good deal depends, I suppose, on how much mechanical engineering and inventing is reckoned as research.

5. The amount of money that can be spent on anything in industry depends on the industry being already profitable, and this depends on the rate at which capital is turned over, the cost of hiring capital (interest rates), and the profit on the selling price of the wares.

In the glass container industry as a whole, capital is turned over about once a year, which is fair, but not too good.[3] Interest rates at present are very low, which is good, except that it is tied in with the third item, viz. a low profit on the selling price, which is more or less what causes interest rates to be low. Further taxes are high, and while money devoted to research is not directly taxable, being expense, yet the government may require us to capitalize it, so that it becomes partly taxable, and can only be amortized by degrees.

6. In modern industry, the capital needed per employee varies from about $5,000 to $8,000 in different industries. There is some evidence that it must shortly approach $10,000, for with shortened hours and higher wages, and a vast array of taxes assessed against payrolls, everything must be done to make each employee produce a maximum of results. This can only mean giving him more and more equipment, or in other words increasing the capital investment per employee.

I have not been able to ascertain with any real accuracy what the optimum investment per employee is in research, but I think it tends to come close to the figure in industry. Up to date, I have been inclined to figure that some $6,000 per employee was needed,[4] involving some $2,000 to $3,000 for the buildings, services, and general fixed assets, and some $3,000 to $4,000 for equipment of a more or less moveable nature.

Until this investment is made, the men cannot function usefully, except in such fields as purely mathematical research.

It must be clearly understood that the investment above mentioned is an average, and applies to a whole organization, not necessarily to an individual worker. An astronomer working with a 200-in. telescope needs an investment of millions. A mathematician computing a lens or the path of a comet needs much less. A typist needs little in the way of either equipment or space, but her boss may need enough of both for two.

7. It is the experience of several research laboratories of my acquaintance, that the annual cost is divided about equally between salaries and overhead.[5] The overhead includes consumable supplies, but does not include the rent of the building, or its equivalent. This is therefore not strictly accurate bookkeeping, and if we have $100,000 a year to spend, and no more, we must first allow something for the rent of a building (even if it is our own) and then we can divide the residue 50-50, to see what we can afford in salaries. This rent must include taxes, as well as depreciation: it may be wise to make provision for obsolescence, for some kinds of research work destroy the building's utility for continuing research, though this is not likely to be the case in our particular instance. However, it would seem wise to set aside some $10,000 a year for "rent," taxes, and so on, and not figure on more than $90,000 for actual research.

Then on the basis of experience $45,000 can be spent on salaries, and wages while $45,000 will go into consumable supplies, including equipment that is used for a brief time, and then wears out, or ceases to meet the needs of the situation.

8. It is probable that the average salary, or annual wages, of an individual will *average* $2,000 or thereabouts, so that the total staff will be about 20 to 25 men and women. This includes janitors and typists as well as research men proper, mechanics, and junior staff.

If we take the lower figure (20 men and women) then the necessary capital investment is (at $6,000 per individual) $120,000, of which probably $50,000 is in the building and $70,000 in the equipment of the individual workers.

9. Of the 20 men and women, not more than half will be first line research workers, that is, not more than 10, and perhaps only 6 or 8. If there are 25 men and women, there may be 10 or possibly more research workers of the first line.

10. The situation will be quite different according as the number is 6 or 12. For it seems to be held that no man can properly coordinate the work of more than 5 others, if their work overlaps. Thus the Director of Research (one man) and 5 first line men (total 6) makes a workable team; but a director and 10 men does not.

In the latter case we need a more elaborate administrative, which would naturally take the form of a director, two assistant directors, and eight first line men. This will work out if there is some natural way of splitting the research work into two divisions.

This is commonly entirely practicable, but the method of splitting may vary a great deal. We might have a group of physicists and a group of chemists; or a group of mechanical engineers and a group composed of chemists and physicists. Or we might have a group of experimentalists and a group of pilot-plant workers.

11. There is a further complication, that at this particular level of intelligence (research work) self-governing and self-coordinating groups cannot as a rule exceed ten in number of individuals. Navvies can function in groups of 20, but machinists cannot exceed about 10, and research workers must be grouped in no larger numbers.

12. This leads us to the conclusion that since an average first line research worker can keep one assistant very busy without getting idle himself, the final set up (for 25 people) would run something like this.

	Director	
Asst. Director	Asst. Director	Chief Mechanic
4 first line men	4 first line men	Machinist
4 assistants	4 assistants	Janitor
		Store keeper
	2 or 3 secretaries	

13. Now this setup cannot be purchased ready made, nor can it be suddenly assembled and expected to function. It has to grow somewhat slowly, like a family. The work is too complicated for raw recruits, and even if the men have already had a good training in research, and

even if they have some knowledge of the industry, yet if they are strangers to each other, it is going to be some time before they settle down and get their bearings. Further, a natural leadership has to establish itself. The imposed leadership will not be accepted unless it proves capable of natural leadership. The men will fret, and quit, or fail to get results.

14. It has been my experience that a research organization can grow naturally at the rate of 50 per cent per annum, compound interest. Other people's experience may be different. Perhaps it is possible to double the staff each year. I suspect that the natural law is that the people who have settled down should outnumber the unsettled newcomers. Now since it generally takes nearer two years than one for a man to settle down, particularly if he is in a new town and new home and social environment, as well as in a new job, and since, further, there is bound to be some labor turnover even if the organization is stationary in size and not growing at all, it seems likely that a growth rate of more than 50 per cent per annum is apt to produce instability, increase of labor turnover, and inefficiency. Sometimes, however, the risk must be taken, for instance in war time or in a desperate industrial situation. But the management should understand the risk.

15. At the beginning, stability can in general be lent to the research organization only from outside. Suppose one man is chosen, and that he has great potentialities. Yet on the supposition that he is new to the firm, he cannot get oriented or "settled" except under the pressure of the settled staff of the firm, that is, people outside the research organization. At this stage of the game, the man, however able, is not a leader; he is an apprentice. Unfortunately he must in the nature of things be too old for the existing staff to think of him as an apprentice, and he is in a most unenviable position. If he is sufficiently flexible, he will come through, but a year or so ought to be allowed for the process.

16. One of my old tutors used to say that if he had a research project, he would never put one man on it, but always two. They sharpened each other's wits. It has been my experience that while the last statement is true, the procedure is not always applicable, certainly not until a research organization is already in existence, so that the project can be formulated in terms the research workers can understand. Only rarely can a non-technical man explain what it is that he wants to the technical man who has to get it for him. An interpreter is needed. Commonly the Director of Research is ultimately that interpreter. But until he has qualified as such, no large organization can be set up.

It is supposed, or rumored, that one glass manufacturing firm recently got into an impasse by attempting to establish a large research group too hurriedly, and had to reduce it drastically.

17. Assume we give the first man a year to get his bearings. At the end of a year he can be given an assistant, and at the end of two years there can be three of them. The growth on the above basis would be somewhat:

Year	*Personnel*	*Year*	*Personnel*
0	1	4	7
1	2	5	10
2	3	6	15
3	5		

And it would not be till the 7th year that is reached the full complement of 22.[6]

18. It is not certain that the process would be quite so wooden as above indicated. If the rate of growth were 60 per cent instead of 50 per cent, the time might be sharply reduced.

It is conceivable also that a reduction of a year or two might be accomplished by lifting bodily, from some other place, a group already accustomed to working with each other. This resembles the procedure of the last Great War, when groups of Geophysical Laboratory men were moved bodily to glass plants to solve the problem of optical glass production. The immediate results were remarkable, but it seems to have had next to no permanent effect upon the companies to which they were assigned.

19. From what has been said above, it will be evident that it is not usually possible to spend $100,000 at all usefully the first year. In fact, it might be difficult to spend a quarter of that amount without waste. True, a permanent building costing $50,000 *could* be erected, but the solitary occupant would be very much lost in it. In fact it would be a most depressing experience. And if he tried to fill it quickly with occupants in defiance of what has been said above, then the organization is going to break down, and a hopeless inefficiency result. Only a superman could salvage it.

It would seem far better to use smaller, temporary quarters, for three or four years.

20. If the postulated $50,000 for the building and its fitments is accumulated over 4 years, we need $12,500 a year to be set aside as a sinking fund. The salary roll will average more than $2,000 a head the first few years, as some of the more expensive men must be obtained first. But by the 4th year, when 7 employees are postulated, some will be assistants, mechanics, janitors, or typists, and a normal setup will be in sight. The payroll might be $20,000; the equipment and consumable materials will reach $20,000 or possibly a little more, and the sinking fund of $12,500 will bring the total to $50,000 or thereabouts. In the 5th year there will be no sinking fund: the building is now supposed to be erected, and the sinking fund's place is taken by the rental and tax column, which should be somewhat less. There will be a slight increase in payroll, for there will be 10 people instead of 7, though the chance are that they will be largely second-string men.

But it is not till the fourth year that even so much as $50,000 can be spent, and even this is one-fourth sinking fund and not strictly expense. In the first year or two the wise expenditure cannot be more than about half this.

21. It is sometimes possible for two or more firms which are actually competitors to agree on a joint program of research which will help them in competition with other industries, other nations, or something of that sort. Unless there is some competitive advantage somewhere, they will not be very enthused, and while they may sponsor some project for charity, it will be a gesture and gesture only. (*Continued on Page* 175)

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[1]In a private communication Dr. Mees advises me that at the present time the figure should be 2 per cent and that it is going to increase.

[2]Or $3,000,000 on the 2 per cent basis.

[3]Some firms come near to turning over their capital twice in one year.

[4]Since this was written, one or two administrations have confirmed this figure, though others do not know what the figure really is in their plants.

[5]Well established laboratories seem to find the overhead a less proportion of the total, at any rate outside the glass industry, but two or three laboratories within the industry confirm the estimate above given.

[6]Dr. Mees informs me that several firms have succeeded in establishing a good organization distinctly faster than above outlined.

TOLEDO TRIAL ENTERS ITS SECOND MONTH

Court and attorneys inspect glass making processes at Alton plant of Owens-Illinois. F. Goodwin Smith, still on stand, nearing end of his testimony. Government believes much of the record so far is damaging to the defense.

The Federal Court of Toledo, Ohio, with all of its functionaries and attaches, was transformed into an elementary class in the science of glass making on March 22 when Judge Frank L. Kloeb and others connected with the government's anti-monopoly case adjourned to Alton, Ill., to inspect the plant of the Owens-Illinois Glass Co. which is located there. The trial, about to enter its second month, had reached a point where all felt it would be advantageous to see in operation the various processes which have been referred to by technical terms in the testimony. The gob method of feeding molten glass into the forming machines, as distinguished from the suction method, were easily differentiated. With Judge Kloeb, his secretary, the clerk of the court, attorneys for the defendants and the government, and newspaper reporters; the party numbered about 20 persons.

Ever since the trial began on March 3, Mr. F. Goodwin Smith, president of the Hartford-Empire Co., has continued to occupy the witness stand under the sometimes severe grilling of Samuel S. Isseks, special assistant to the attorney general. Mr. Smith admits he is tired and has expressed a desire to get back to his business, which he said he has been forced to neglect for many months. Indications were that he would complete his present testimony the first week in April. He will be subjected to some direct examination by his own attorneys, and may be recalled as a defense witness later in the trial.

The Government attorneys feel that the testimony they have caused to be introduced into the record has been damaging to the defense. They point to the fact that in numerous letters and documents, the writers, which include high officials of the defendant firms, have expressed their purpose to create a monopoly and to eliminate certain competitors and competitive practices.

Quotations which government attorneys are said to consider the most damaging included the following statement of the three main purposes of the Hartford-Empire organization, written by the late Herbert Knox Smith, official of the firm, in 1930:

1. To cover actual machines we are putting out and to prevent duplication.

2. To block development of machines which might be constructed by others for the same purpose as (our) machines.

3. To secure patents on possible improvements of competing machines, so as to "fence in" those and prevent their reaching an improved stage.

Another exhibit, describing negotiations between Corning Glass Works and Hartford-Empire, contained the following paragraph:

"Corning wanted to make containers out of ordinary glass at standard royalties. To grant any such right is contrary to Hartford's present and long established policy of endeavoring to limit competition between its licensees within reasonable bounds, and Hartford, especially at present, would be quite adverse to putting into this very competitive field a new and powerful competitor."

In this connection government lawyers emphasized the fact that a longhand note scribbled below the paragraph and then crossed out said: "In any event, our Owens agreement prevents our granting this without the consent of Owens."

A letter, dated June 25, 1923, concerning negotiations between Owens and Hartford officials, read in part as follows:

"Belknap (Charles B. Belknap, then patent attorney for Owens) believed that in spite of what we would have to pay the scheme would result in such a monopoly that we would get our money back many times."

Another quotation from the same letter follows:

"It was the understanding between Belknap and myself, as the purpose had in view was to establish a monopoly as soon as possible, that Owens should pursue Federal and one or more Miller Licensees with vigor (we bearing half the expense) with the expectation that Federal would sell out if given (say) one-third of their present income and that Miller would for a small cash consideration abandon his licensees by withdrawing from the interferences, leaving them to be settled between Hartford-Empire and Owens."

Defense attorneys explained that the word "monopoly" is generally used loosely by patent attorneys, since they refer, not to the widely accepted connotation of illegality, but to the fact that a patent is in itself a legal monopoly. They further pointed out that it was perfectly natural for the glass manufacturing leaders to attempt to acquire control of the smaller firms which they regarded as pirates. Patent interferences, it is said, at times had the glass industry almost paralyzed.

However, the government suffered at least one important set-back in a ruling by Judge Kloeb in which he denied admission of portions of the Herbert Knox Smith diary, which has been used throughout the trial by Mr. Isseks in attempting to refresh the recollection of the witness. Mr. Smith, the witness, testified on one occasion that his associate of the same name had a "personal habit" of writing down long accounts of all his activities and even thoughts concerning business.

The trial has been marked by a surprising amount of sparkling wit, contributed chiefly by one of the Hartford attorneys, Edgar Goodrich. There have been several heated clashes between attorneys over minor issues, but the feeling has been friendly, generally speaking. So friendly, in fact that government and defense attorneys were found holding bridge hands in the same game on the trip to Alton.

The prosecution has taken step by step the story of the development of the glass industry to its present status, showing the early history and the subsequent series of amalgamations, which were common to all branches of

(*Continued on page* 178)

CURRENT STATISTICAL POSITION OF GLASS

February witnessed a continuation of record breaking activity in the glass industry with a new high in production recorded for this month of the year; this was accompanied by similar trends in employment and payrolls. According to THE GLASS INDUSTRY'S Production Index, February output totalled $32,000,000 as compared to $27,000,000 last year. Cumulative figures for the first two months of the year indicated a production of $66,000,000 which was 15 per cent more than 1940's record figure.

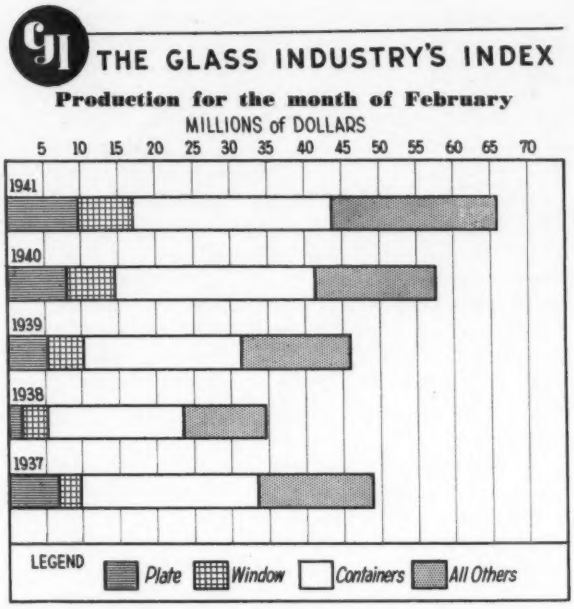
Plate glass production during February totalled 15,664,223 square feet according to the Plate Glass Manufacturers of America. This represented a decline of 19 per cent from the January figure, following the usual seasonal trend, but was 19 per cent greater than last year's comparable total. During the first two months of 1941 plate glass output amounted to 35,014,000 square feet as compared to 30,432,000 last year—a gain of 15 per cent.

Window glass output during February dropped 11 per cent from the January figure to 1,397,082 boxes. This brought the total for the first two months of 1941 up to 2,958,000 boxes which was 18 per cent greater than last year's comparable figure. The industry operated at 86 per cent of capacity during February, as compared to 68 per cent in the same month of 1940.

Glass container production was at the all-time February high of 4,368,101 gross according to the Glass Container Association of America. This was 3 per cent less than the January total, in keeping with the usual seasonal trend, but it was 6 per cent more than in February 1940. All types of ware, with the exception of beer and liquor bottles, were produced in greater quantities. During the first two months of 1941, glass container output amounted to 8,885,000 gross, as compared to 8,386,000 gross in 1940—an increase of 6 per cent.

Shipments of glass containers during February were contra-seasonally higher than the previous month's volume, having increased 2 per cent to 4,273,331 gross—also a new record. This was 11 per cent above the February 1940 level. Compared with last year, all lines of glass containers were shipped in larger amounts. Pressure and non-pressure ware was up 36 per cent, general purpose ware 28 per cent, milk bottles 18 per cent, beer bottles 16 per cent and food containers 15 per cent; smaller increases were reported for liquor ware (up 4 per cent), and medicinal and toilet ware (up 3 per cent). Cumulative totals for the first two months of the year placed 1941 shipments at 8,450,599 gross as compared to 7,567,012 gross last year. These figures indicate that this year's trade is running about 12 per cent ahead of 1940.

Glass container inventories as of February 28, 1941, amounted to 10,097,177 gross which was 3 per cent greater than last year's comparable figure.



Miscellaneous glass products produced during February had a value of $11,000,000, equalling the previous month's total and exceeding last year's volume by almost

CURRENT GLASS CONTAINER STATISTICS

(ALL FIGURES ARE IN GROSS)

Types of Ware	1941 *Prod. Mo.*	1941 *Prod. Yr.*	1941 *Ship. Mo.*	1940 *Ship. Mo.*	1941 *Ship. Yr.*	1940 *Ship. Yr.*	1941 *Stock*	1940 *Stock*
Food Containers (Narrow neck, wide mouth and pressed)	1,154,715	2,255,245	1,150,782	1,016,851	2,341,350	2,015,657	2,094,170	2,012,945
Pressure and non-pressure ware	383,997	734,922	274,824	204,700	498,972	347,419	1,004,312	869,011
Beer Bottles	270,291	564,870	166,529	142,693	306,852	267,385	801,767	949,242
Liquor Ware	574,392	1,186,730	676,290	646,459	1,264,275	1,208,563	1,625,715	1,498,525
Medicine and Toilet Ware	1,440,278	2,992,594	1,433,399	1,368,095	2,900,961	2,780,207	3,118,317	3,008,042
General Purpose Ware	308,025	650,965	351,458	274,522	688,649	568,902	622,346	506,206
Milk Bottles	197,397	404,051	198,759	168,356	404,439	348,493	296,835	310,449
Domestic Fruits and Jellies	22,586	63,023	7,749	1,739	16,658	5,032	497,306	617,383
All Others	16,420	32,301	13,541	11,825	28,443	25,344	36,407	35,436
Industry Total	4,368,101	8,884,701	4,273,331	3,835,240	8,450,599	7,567,012	10,097,177	9,807,239

30 per cent. During the first two months of this year, this branch of the industry increased its output by more than 20 per cent.

According to a preliminary report of the Census Bureau, 12 firms manufacturing illuminating ware reported February sales totalling $678,000, which was 25 per cent over February 1940 and two per cent over January 1941.

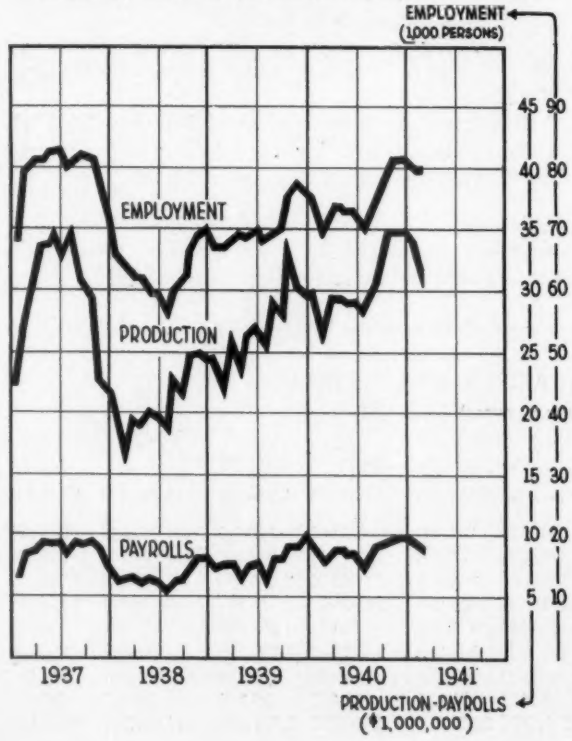
Machine made tumbler production during February amounted to 3,694,357 dozens. This was 8 per cent greater than last year's comparable figure. However, due to reduced volume in January, output during the first two months of this year was 3 per cent under the 1940 total. Shipments were also greater in February of this year, having increased 9 per cent over February 1940 to 4,004,180 dozens. This counteracted January's decline, bringing the cumulative figure for the first two months up to 6,645,325 dozens—about equal to 1940's volume. The excess of shipments over production reduced end of the month stocks to 8,419,450 dozens, which was still 11 per cent more than they were at last year's same date.

Manufacturer's sales of machine made table, kitchen and household glassware during February totalled 2,905,379 dozens which was 5 per cent less than last year. A volume of 32,988,081 dozens was reported for the 12 months ending February 28, 1941.

Employment and Payrolls: Approximately 80.300 persons were employed in the glass industry during February, which indicates that there was little change in this situation from the previous month. This compares with 71,500 persons in February 1940.

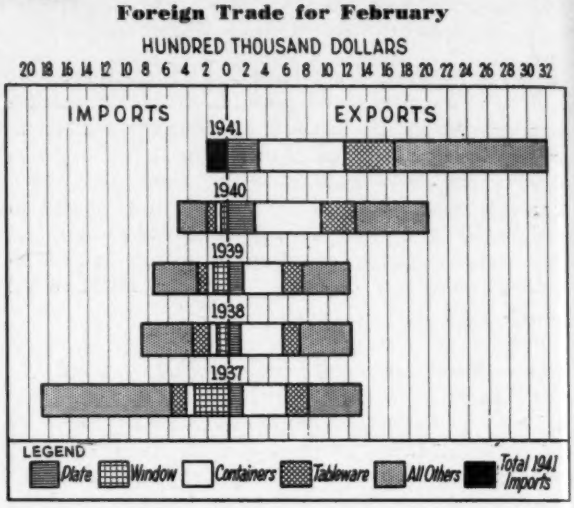
THE GLASS INDUSTRY'S INDEX

Monthly Trends Through February, 1941



THE GLASS INDUSTRY'S INDEX

Foreign Trade for February



Glass manufacturers paid out about $9,200,000 in wages during February, which was less than the January total of $9,900,000 but was 15 per cent more than last year's comparable figure. During the first two months of 1941 glass payrolls totalled $19,100,000 as compared to $16,400,000 in 1940.

Foreign Trade: Exports of glass and glass products during February reached the record total of $1,634,000 which was 3 per cent above January's high level. Window glass exports dropped 7 per cent and illuminating ware was off 30 per cent but these declines were counteracted by a 21 percent increase in plate glass, a 24 per cent increase in tableware and a 4 per cent gain in containers. Compared with last year's total this February export volume represented an expansion of 70 per cent. Foreign sales of all lines were accelerated with window glass shipments 12 times greater than in February 1940 and increases of 134 per cent reported for plate glass, 27 per cent for containers and tableware, and 33 per cent for illuminating ware during this same period. Cumulative totals for the first two months of 1941 placed exports at $3,216,000 which was 60 per cent greater than last year's total.

Imports of glass and glass products during February dropped 16 per cent below the January figure to the new low of $89,000; this was a decline of 58 per cent from February 1940. The first two months of this year imports were valued at $195,000—60 per cent less than last year.

FOREIGN TRADE STATISTICS

(VALUES IN $1,000)

Exports	*Feb.* 1941	*Jan.* 1941	*Feb.* 1940
Plate	182	150	78
Window	156	168	13
Containers	440	425	347
Tableware	235	190	185
Illuminating ware	69	98	52
All other	552	551	286
Total	1634	1582	961
Imports			
Total	89	106	214

SIGHTS TO SEE AT THE A.C.S. MEETING

Glassmen attending this year's meeting of the American Ceramic Society should plan with more than usual care to take in the sights of Baltimore, which include some of the nation's foremost historic shrines, collections of glassware, four prominent container plants, and many industrial show places.

Probably no city selected by the American Ceramic Society for its annual meeting has ever had so much of interest to offer the ceramist visitor as Baltimore. The appeal is both varied and distinctive. An outstanding center of education and science, her museums, hospitals, medical centers and schools are known the world over. Her landmarks and monuments commemorate important events in American history. A glass manufacturing city since very early times, her museums and gallerys contain choice specimens dating far beyond the Christian era. As the eighth largest city in the United States her arteries of commerce include a transatlantic airport and a harbor, both spacious and magnificent, that is numbered among the truly great harbors of the world. Baltimore is a tremendous user of glassware of all kinds, and her distilleries, food factories and proprietary medicine establishments, many of them are outstanding.

Ancient Glass

The glass collection at the *Walters Art Gallery* comprises objects ranging from an Egyptian piece, such as a New Kingdom Cup in the shape of a lotus flower and a glass weight with Kufic inscription in relief in a central roundel from Syria dating from the eighth century, through examples from Rome, Persia, France, Spain, Germany and Italy together with examples from nearly all centuries and types. Certain of the most important objects illustrating the various periods and methods in glass technique have been placed on public view so that a comprehensive history of glass can be enjoyed.

One of the outstanding pieces in this collection and also in this country is the thirteenth century glass window that is said to be from the Tour de Plumb in the Cathedral of Sens and given by the Archbishop Etienne de Becard de Penoul and Pope Celestine II in 1294. This window has been installed in the foyer of the Gallery where it can be seen to great advantage, particularly in the afternoon when the light is most favorable.

Glass vases, first made by the Egyptians, were a development from the Egyptian vessels of faience, a material consisting of a frit core and a pure glass coating. This origin they betrayed until the end; for they were always made by winding and fusing rods of glass on a sandy core which had afterwards to be removed. Egyptian glass was always opaque, never transparent. The vessels were usually decorated with zig-zag inlays of glass rods of various colors melted into the body.

Such vases (Fig. 1) were made by the Egyptians and their neighbors during the great days of the Egyptian Empire, about 1400 B.C. The latest examples (Fig. 1) were exported and supplied the needs of the Greeks, who were not themselves good glass workers.

Later glass was moulded and blown instead of core-wound, and it became transparent. Small, plain, blown glass bottles are preserved by thousands from Roman days. They held ointments and perfumes. Vases made in this way could be decorated by the application of tiny threads of glass (Fig. 2) or glass ribbons of various colors (Fig. 3). Then, too, an incompletely stirred mixture of colors could be blown to make a vari-colored vase (Fig. 4).

The glass worker neared perfection in the creation of the *millefiore* (thousand flower) vessels. Sometimes, too, he engraved his glass vessels, either on a lathe or free-hand, and in late antique days he began to gild and paint them. In fact, there is little in the way of decorating glass vessels that the Romans did not know and practice. Their glass was inferior to ours, however, in hardiness and in perfection of form.

Points of Interest

Fort McHenry is one of the nation's foremost historic shrines, the birthplace of The Star Spangled Banner. The original manuscript of the Star Spangled Banner is on exhibit at the *Walters Art Gallery*, which also houses the magnificent art collection of the late Henry Walters.

Fig. 1. Egyptian vases, among the oldest specimens of glassware in existence, which will be on exhibition at the Walter's Art Gallery, Baltimore, during the annual meeting of the American Ceramic Society. The first and fourth vases date to approximately 1400 B.C., while the third and fifth are examples from a somewhat later period.

Fig. 2. A molded Roman vase of glass. The decoration consists of very small threads of glass applied to the surface — a favorite form of early Roman decoration.

Fig. 3. A Roman vase, of white glass with ribbons of yellow and green. This vase was made at Cologne-on-the-Rhine, a factory which specialized in this ribbon technique.

Other celebrated collections of art are to be found in the *Baltimore Museum of Art*, and the *Municipal Museum*. The *Enoch Pratt Free Library* is one of the largest and most modern of free libraries to be found anywhere in the world.

Baltimore has a number of outstanding monuments. Among them are three firsts—the first monuments ever erected to Christopher Columbus, George Washington, and Francis Scott Key. The tomb and grave of Edgar Allen Poe is also noteworthy.

Quite unique among the city's points of interest is the *Shot Tower*, built about 1828. It is a massive brick pile, 160 feet in height. A spiral stairway leads to the top, from which point molten lead was dropped into a pool of water at the base. This lead formed itself into the proper shape as it fell.

Two homes of the great architectural beauty are *Homewood House* and the *Carroll Mansion*. The former is located on the campus of Johns Hopkins University. Constructed in 1801, it was the wedding gift of Charles Carroll to his son. Charles Carroll, a signer of the Declaration of Independence, lived in the Carroll Mansion. Both homes are lovely examples of colonial architecture.

At Cathedral and Mulberry streets is located the *Catholic Cathedral*, considered to be the "mother church" of all catholic churches in this country.

The *Johns Hopkins University Medical School and Hospital* are part of a great educational institution founded in 1876 under the will of the Quaker whose name it bears. The medical school and university, consisting of 25 buildings, containing almost a million square feet of floor space, are separated from the liberal arts and engineering buildings, which latter are situated at "Homewood." Johns Hopkins University marked a new era in medical education. Here, for the first time, a medical student was brought into intimate contact with the patient as a part of his training.

Baltimore is the home of four prominent glass bottle manufacturing concerns: Carr-Lowrey Glass Co., Buck Glass Co., Maryland Glass Corporation; and Swindell Brothers, Inc.

Close to Baltimore is Annapolis. Although Annapolis boasts of many beautiful buildings and historical spots, these have become overshadowed by the *U. S. Naval Academy*.

Fig. 4. Roman vase of amber glass, blown in a mold. The Greek inscription "Receive the Victory" has puzzled the interpreters. An actual athletic victory? Or merely for a toast of honor?

INVENTIONS AND INVENTORS

A Summary of United States Patents of Interest to the Glass Industry Issued During February

Compositions

A suggestion for improving ruby glass compositions derived from the duPont work in this field appeared Feb. 25 in patent 2,233,343 issued to Frank J. Dobrovolny and Charles H. Lemke. They report the discovery that a very small addition of bismuth to a conventional copper ruby glass batch has a marked effect on the color development. Any one of a number of bismuth compounds may be used so long as the equivalence of the oxide does not exceed 0.3 per cent. As with ordinary ruby glass, the full color is not developed until the lehr treatment at 550 to 600°C. The inventors state that the bismuth is so effective as to result in the production of a rich red color with percentages of cuprous oxide which would be far from sufficient in ordinary practice.

Philip E. Harth of Clayton, Mo., was granted patent 2,233,259 which covers broadly "surface-treated foliated glass." The object is to produce a foliated glass in the form of leaves, thin plates, or laminae suitable for use in paint and elsewhere. The glass is attenuated until it reaches a foliated condition, for example by blowing a glass bubble until it breaks or fractures. Sheets as thin as a micron in thickness are reported to be formed by such methods. As one example of the many surface treatment processes with which the patent is concerned. Mr. Harth coats the foliated glass with salts or minerals by dry electro-deposition or by fuming or sublimation.

George J. Bair of Pittsburgh received patent 2,230,343 on a process of utilizing the fine mixture of glass and sand from plate glass polishing operations which was formerly considered valueless. The mixture is sintered to form a porous agglomerate which is used as a glass batch ingredient. In a second patent to Bair and John S. Cort, Jr., of Kittanning, Pa. (2,230,344), a means of removing finely divided iron grindings from waste sand is described. Both patents were added to the Norbert S. Garbisch group by assignment.

Corning's Top-of-the-Stove Ware

Tempered or case hardened glass which was a scientific curiosity for several centuries has become in recent years a highly practical commercial product. The two major fields of application in safety glass and in top-of-the-stove cooking ware are inherently related although the types of glass compositions are dissimilar. Two Corning glass patents which issued in June 1940 to Wm. W. Shaver described the guenching of glass ware in salt baths to administer the temper (2,205,180 and 2,205,181), but Corning's principal product patent has just issued. This is patent 2,231,811 issued to Jesse T. Littleton, Wm. W. Shaver and Howard R. Lillie.

The development of their top-of-the-stove ware required a consideration of the fact that such ware receives localized heating while oven ware is instead uniformly heated. Glass used on top of the stove will attain temperatures between 150°C and 500°C. It is of course necessary that such heating will not release the tempered-in strain to which the performance of the ware is due. Consequently the ware should be able to hold the strain at least to 500°C. The inventors have found that the strain release temperature is approximately 175°C lower than the strain temperature, and therefore that the strain temperature should preferably be as high as 675°C.

The fact that strains are released on prolonged heating at unexpectedly low temperatures (below the strain point) is one of the basic discoveries claimed by the inventors.

Low thermal expansion is a requisite of glass for this process in order that the ware may have long thermal endurance. Another necessary property is that of high viscosity at the strain temperature. It has been found preferable to choose glass compositions whose thermal expansion coefficients shall not exceed 65×10^{-7} per degree centigrade. If the expansion rate is excessive it is necessary, in order to obtain satisfactory thermal endurance, that a degree of temper be introduced into the article which is such that when it breaks, failure occurs with an explosive fracture so that small bits would be thrown widely. Such a hazard must be avoided in domestic use.

Four suitable glasses and their properties are listed in the following tables:

TABLE I

	A	*B*	*C*	*D*
SiO_2	56.4	60.5	62.5	57.1
B_2O_3	5.0	—	5.2	12.4
Al_2O_3	23.0	21.4	15.6	15.5
Na_2O	0.8	0.6	—	—
CaO	4.1	8.7	10.0	9.0
MgO	10.7	5.8	5.0	5.0
Fluorine	—	1.5	1.5	1.0

TABLE II

Glass	*Softening temperature*	*Annealing temperature*	*Strain temperature*	*Expansion*
(A)	929	726	684	38×10^{-7}
(B)	938	715	672	41×10^{-7}
(C)	888	663	625	40×10^{-7}
(D)	871	639	603	39×10^{-7}

It will be noted that all of these glasses are characterized by high alumina and low alkalies. All have strain temperatures above 600°C. Experiments run by Littleton and his associates have shown that the strain release characteristics are not entirely dependent on the strain

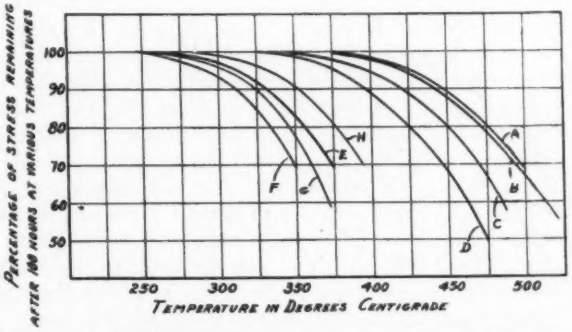


Fig. 1. 2,231,811: Littleton, Shaver & Lillie. For top-of-the-stove ware these Corning men patented glass compositions with a high strain temperature. After a quench to provide tempering, glasses A to D showed marked ability to retain their stressed condition at temperatures of 400° to 500° C which might be reached in domestic use.

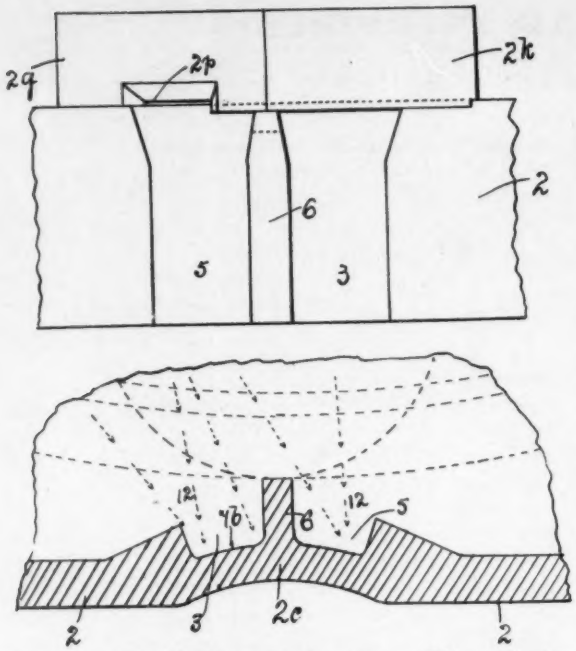


Fig. 2. 2,231,770: Mitchell. A rotary machine gathering glass from pool 3 shears the superfluous glass into pool 5 separated from the gathering pool by a division wall. Furnace flames through a wall opening 2p keep the surface of the return pool heated.

temperature but are also governed to a considerable degree by the length of the setting range between the softening and strain temperatures. This range should not exceed 300°C. For the four glasses cited above the setting range varied from 245 to 268°C.

Fig. 1 illustrates the strain-retaining characteristics of glasses A, B, C, and D and of four other glasses for less severe types of service. These curves show the percentage of stress remaining after the glasses have been heated for 100 hours at various temperatures. In the group A to D the strain release varies from 10 to only 32 per cent at 450°C. It is obvious that such compositions would stand many hours of service, providing of course that other properties are satisfactory.

Although the patent contains no claims directed to the process itself, the method of manufacture is briefly described as applied particularly to the glass of composition A. The glass is worked at about 1300°C. Articles, machine-formed by pressing, are conveyed to a temperature equalizing oven maintained at about 900°C or above. This must be above the annealing temperature and should be as high as possible without resulting distortion of the article. The annealed ware is then chilled in a bath of molten salts held at about 525°C. This causes a sudden hardening or stiffening of the glass and introduces tensional and compressive strains into the glass which contribute greatly to its thermal endurance and resistance to mechanical shock. The salts are removed in a bath of water at room temperature. This imposes a thermal shock which discloses the presence of defective ware.

Furnaces

Fig. 2 illustrates the construction of a unique gathering pool from which a rotary forming machine may gather glass by suction means. The inventor Wm. B. Mitchell of Bradford, Egland (2,231,770), was concerned primarily with positive means for returning the cooled cutaway portion of glass to the main body of the furnace. The gathering pool 3 and the return pool 5 are circular in form to conform to the shape of the machine. The gather form pool 3 is carried by the suction cup across a division wall 6 so that the shear returns the chilled glass to a separate pool from which it re-enters the furnace. The wall of the furnace dips into the glass at the gathering pool but is cut away at 2p above the return pool so that the superfluous glass will be more readily kept in a molten condition by furnace gases.

Another approach to the same problem of obtaining a satisfactory return of superfluous glass from the forehearth is revealed in patent 2,230,608 to Robert W. Canfield of West Hartford, Conn. (Hartford-Empire). He provides two circulators or stirring heads (see Fig. 3) which aid the flow of glass into the forehearth and its return at a lower level. The inflow and return levels of glass are separated by a refractory horizontal division floor.

Feeding, Forming and Shaping

Patent 2,230,609 granted to Madison M. Cannon, Jr., of West Hartford. Conn. (Hartford-Empire), is concerned with a spray mechanism for spraying liquid and air to cool a shearing device. The spray is maintained substantially uniform even when unintentional changes occur in the rate of supply of the liquid.

An improvement in the type of pneumatic feeder which provides a predetermined weight and shape of charge was patented by Peter Kucera of Allison Park, Pa. (2,230,597 assigned to Hartford-Empire). In this type of feeder as illustrated by Fig. 4 the refractory bell-shaped element is supported by a metal shank through which vacuum or super-atmospheric pressure may be applied. The performance of such a feeder is said to be somewhat short of perfect due to leakage of air between the shank and the bell and even through the porous walls of the bell itself. To overcome these difficulties Kucera proposes a preliminary step in which the glass is drawn upward above its uppermost normal operating limit so as to form a protective hermetic seal over the entire wall and over the joint between the bell and the metal shank.

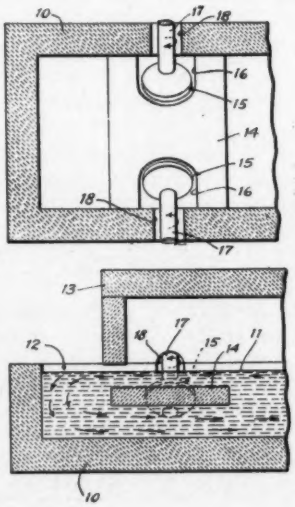


Fig. 3. 2,230,608: Canfield. Circulation to the forehearth is aided by two powered stirring members 15. The return flow passes under a horizontal division floor 14.

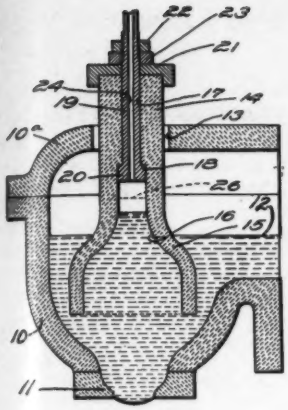


Fig. 4. 2,230,597: Kucera. A pneumatic bell feeder is given a seal to prevent air seepage, by a preliminary suction of glass which leaves a glazed coating over the entire surface.

Miscellaneous Processes

Automatic ware handlers such as the Hartford stacker, which transfers bottles for annealing from receiving stations to the lehr conveyor, give no warning when an article topples over. Inequalities in the conveyor surface may thus result in considerable loss of ware since one article toppling backwards may interfere with the operation of the stocker by causing subsequent articles to fall. In patent 2,230,605 Clarence F. Bird of Chattanooga assigns to Hartford-Empire the rights to a device which signals an operator whenever tipovers occur. As shown in Fig. 5 a falling bottle strikes the arm 17 knocking it from its normal horizontal position and thereby closing a circuit which operates a signal.

Albert F. Tremblay of Toledo (Kent-Owens Machine Co.) received patent 2,232,285 for a transfer apparatus adapted to receive articles from a forming machine for delivery to a stationary chute.

Patent 2,232,638 granted to Franz G. Schwalbe of Toledo is directed to the improvement of lehrs heated by hollow gas-flame radiants. The lehr may be separated into zones by curtain walls. The invention provides means for regulating and directing the movement of air within the lehr, as by supplying pressure to the heated zone. The radiants are connected by openings to the tempering chamber into which gas may be forced by individual pressure regulators.

William J. Scott of Rugby, England, assigned to General Electric Co. his patent 2,232,807 for an apparatus for applying powders to the inner wall of open ended glass vessels.

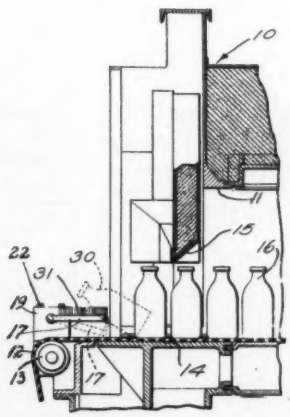


Fig. 5. 2,230,606: Bird. The tip-over of a bottle entering a lehr from an automatic stocker operates a signal device to summon the operator.

A decorating apparatus which utilizes the screen process and successively stencils two faces of a container is described in patent 2,231,553 assigned by Leonard D. Soubier to Owens-Illinois Glass Co.

Plate and Sheet Glass

Plastic substances for laminated glass sheets were patented by Joseph D. Ryan of the Libbey-Owens-Ford Glass Co. (2,232,806) and by Rowland Hill of Manchester, England (2,231,471 assigned to Imperial Chemical Industries, Ltd.). Ryan's plastic is a polyvinyl acetal resin formed by the reaction of a saturated aldehyde on a hydrolyzed polyvinyl ester. Hill's plastic sheet consists of two esters of methacrylic acid including an interpolymer of methyl methacrylate.

Two patents for sheet glass cutting machines 2,230,694 and 2,230, 651 were granted to Joseph R. Morris of Toledo (Libbey-Owens-Ford).

Ernest Delacuvellerie of Brussels has designed an elastic deformable roller, for sheet drawing apparatus, which is made of numerous rings which assure improved contact with the glass (2,231,857). As shown in Fig. 6 the rolls "e" are eccentrically supported on driving shafts from which their motion is obtained frictionally.

Another patent in the fairly large group issued to Libbey-Owens-Ford Glass Co. last month was 2,232,765 to Chas. E. Bliven of Charleston, W. Va., for conveyor rolls used in sheet glass annealing lehrs. Ordinarily the sheet is conveyed through the lehr on a series of spaced rolls, of which a common type consists of a steel shaft covered with asbestos discs. The discs are clamped tightly together by means of metal tie rods. Difficulty develops due to the loosening of these discs when the tie rods expand. Bliven's patent provides collars fixed at each end of the shaft and drilled to form passages for the tie rods on which the asbestos discs are threaded. By making the tie rods of Invar or other metal of low expansion, the result of expansion of the metal shaft is an actual tightening of the asbestos discs.

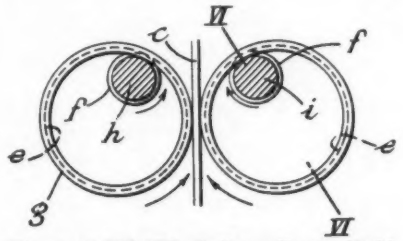


Fig. 6. 2,231,857: Delacuvellerie. Yieldable drawing rolls "e" made up of many narrow rings are turned frictionally by powered shafts "h" and "i" on which they are eccentrically supported.

Glass Wool and Fiber

Four patents issued to Owens-Corning Fiberglas Co. were concerned with various aspects of the fiber art. In patent 2,230,270 Donald Simpson of Newark suggests a means for controlling the width of the fiber mat formed in the orthodox machine wherein the downwardly blown fibers are shaped into matted form on a conveyor belt. He brings the sheet metal walls of the collecting cham-

(*Continued on page* 180)

NEW EQUIPMENT AND SUPPLIES

IMMERSION THERMOCOUPLE

The Brown Instrument Company, Philadelphia, has developed a deep immersion thermocouple for molten glass. The thermocouple was primarily designed for feeders, but is of considerable value for measuring any molten glass temperature. It may be used in a glass feeder, or in a glass pot or tank.

On glass feeder installations, a molten glass thermocouple will measure temperatures at a point where they are always significant of the actual gob temperature. The rare metal protecting sheath will not discolor or contaminate the molten glass.

The couple itself is portable in the sense that it can be moved from one location to another without damage. The thermocouple wires can be replaced easily and quickly without removing the protecting tube. With this couple, the point of temperature measurement is always the same because the protecting tube is rigid and will not bend at high molten glass temperature. The couple is very sensitive and insures a faster response to changes in temperature of the glass being used to form the gobs. It is unaffected by the wide changes in ambient temperature (diurnal swings). Complete details of this new thermocouple are illustrated and described in Bulletin No. 22-31.

FREE-FLOW CONVEYORS

A new vibrating conveyor and feeder, known as the "Free Flow," has been recently introduced by the Standard Transmission Equipment Co., Los Angeles, Cal. The conveyor operates on the lift-throw principle with the motion of the trough becoming increasingly horizontal with the progress of each cycle, thus imparting to the conveyed material a gentle, forward motion. It is claimed that the suspended float-action minimizes wear from abrasion, and the most fragile material can be conveyed without fear of breakage.

The trough is self-cleaning and different materials can be alternately conveyed without residual contamination. The oscillating arms are mounted in special rubber bushings, reducing power consumption. Self-aligning, precision ball bearings are used throughout. The trough can be of any desired material, open or closed for the handling of hot gaseous or dusty materials. Volume can be controlled by means of a variable speed control, and the material can be conveyed up inclines to 15 degrees.

AIR-OPERATED SWITCH

The Cleveland Tramrail Division of The Cleveland Crane & Engineering Co., Wickliffe, Ohio, has developed a new air-operated switch for use on cab-operated, gravity, or automatic dispatch overhead materials handling systems. This development enables the tramrail operator to pre-set the switch at some distance ahead while traveling and lose no time. Indexes on gravity or automatic dispatch carriers may be set to actuate trippers which will cause one or several switches to take positions desired.

The switch is built of welded steel, and consists of two main assemblies—an outer supporting frame and an inner sliding frame. The outer frame is designed for bolting rigidly to the superstructure. The inner assembly carrying a straight and a curved rail, riding on multiple easy operating rollers, and is set in position by an air cylinder. Systems employing Cleveland Tramrail air-operated switches can be furnished in all capacities up to 5 tons.

W. N. BEST CO. EXPANDS

The W. N. Best Engineering Co., Inc., New York, has recently tripled the size of their present quarters by leasing a new plant at Carlstadt. N. J. The company manufactures a line of industrial burners and accessories for liquefied and gaseous fuels.

DIAMOND ALKALI IN TEXAS

The Diamond Alkali Company of Texas was incorporated recently to manufacture and distribute alkalies and other chemicals in Texas. The new company has taken over the Gulf Coast Chemical Company, and will continue to operate this established chemical business as a division. The main office of the Gulf Coast Chemical Division will be maintained in Houston, Texas, as well as branch offices in Dallas and other cities.

The Diamond Alkali Company of Texas has purchased a tract of land in Dallas and within the near future will start the construction of a new plant to manufacture silicate of soda and silicate products. A contract for the erection of the new plant has been placed with the Rust Engineering Company, Pittsburgh, Pa. It is expected that the construction of the plant will be completed and operations commenced in August, this year. This new industry is a further indication of the importance of Texas in the chemical field.

FRANTZ FERROFILTER

The S. G. Frantz Co., New York, has devised a new magnetic separator, Model 68, following the general principles of the screen type wet Ferro-Filter, but adapted to dry sand. A distinctive feature is several layers of vanes over which the sand pours. The magnetized edges of the vanes attract and hold the magnetic particles in the sand stream. The machine has no moving parts and is easily cleaned by turning off the current. It has a capacity of several tons per hour.

CATALOGS RECEIVED

Johns-Manville, New York, N. Y. The 1941 edition of the Johns-Manville Industrial Products Catalog, Form GI-6A. The 52-page illustrated book contains information and recommendations on high and low temperature industrial insulations from 400°F. below zero to 2500°F. above, and associated products.

B. F. Goodrich Co., Akron, Ohio. A catalog sheet on its patented Vulcalock valve. The valve is rubber lined and is suited for handling corrosive and abrasive fluids under conditions of fairly high pressure.

General Electric Co., Schenectady, N. Y. Catalog GEA-2234C, on manual motor-starting switches for control of fractional-horsepower motors; GEA-4369, push-button stations for standard duty; GEA-2599, FH Cubicles that are steel self-supporting, and are shipped completely assembled.

Leeds & Northrup Co., Philadelphia, Pa. A 28-page catalog listing apparatus needed to check thermocouple pyrometers. It illustrates and describes portable equipment for plant tests under operating conditions and the laboratory apparatus to standardize it.

The Brown Instrument Co., Philadelphia, Pa. Catalog No. 1104, Brown Potentiometer Pyrometers. The catalog contains illustrations of the interior and exterior views of indicating, recording and control pyrometers. Also described and illustrated is the Radiamatic Pyrometer with auxiliary switches and control accessories.

Aluminum Ladder Co., Tarentum, Pa. A 44-page catalog describing aluminum ladders for fire fighting, industrial and commercial use. Also included in the catalog is data on gangways, stages, scaffolding, conveyors and special ladders.

Detroit Universal Duplicator Co., Detroit, Mich. A folder on the Detroit Universal Duplicator Control. The Control can be used to control machine tools and provides accurate duplicating control permitting the reproduction of original model directly in metal. The folder shows applications of the unit as applied to various machine tools.

CATALOG & BULLETIN SERVICE

Current catalogs and manufacturers' service bulletins reviewed in this department may be obtained by writing to THE GLASS INDUSTRY.

ORGANIZATION OF RESEARCH DEPARTMENTS

(*Continued from page* 165)

It is also possible for a firm in say the bottle manufacturing industry to collaborate with one in the sheet glass industry in a program of fundamental research, say on viscosity, or devitrification, or chemical durability. For here, in the U.S.A., the firms are completely distinct and do not compete in any way, while both have need of the fundamental information. The chances are, however, that neither would normally agree to centralizing the work at the other firm's plant, and it would have to be done on neutral ground, and even in that case neither would be so well satisfied as if it were done on their own premises.

22. In practically all that has been recited above, we have the advantage of case-histories, usually within the glass industry itself, to back up the statements. The whole story would be much more interesting if it could be told with these illustrations, the way lawyers are educated. Unfortunately, the illustrations are mostly in the nature of mistakes, how not to do things, and to describe them here might be very annoying and embarrassing to very good people. I have therefore contented myself with reciting what I believe to be the essence of such experience as is accessible to me.

It is most likely that others have experience of instances that depart widely from the picture outlined above; but I am not trying to picture extreme instances of spectacular success, or of total failure. All that can be offered is a résumé of normal good practice; and since this country—and others—must come more and more to depend on industrial research to raise its standard of living, there are few things industrially, or socially, more important than to grasp the essence of normal good practice in this particular field.

J. M. McCORMACK TO ARMY

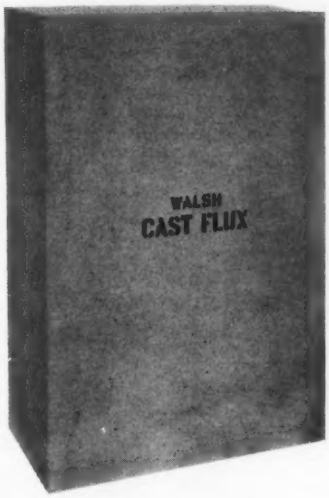
First Lieutenant John M. McCormick of the Preston Laboratories, a reserve officer of the Coast Artillery, joined his battery in January and is now stationed at Fort Weatherill on Narragannsett Bay, Rhode Island. He has charge of the training of some 84 recruits, and in addition acts as Mine Property Officer, Boat Officer, and Battery Exeutive. Lieutenant McCormick in civil life is a mechanical and electrical engineer. For several years he has headed the engineering staff of the Preston Laboratories, to which he expects to return after his term of service with the Army expires.

OWENS-CORNING EXPANDS

The Owens-Corning Fiberglas Corp. of Toledo, has purchased the Lonsdale Company mill in Ashton, R. I., to expand production of Fiberglas. The company has completed plans to adapt the plant to its needs and install equipment by June 1 to manufacture fibrous glass that subsequently is woven into all-glass tapes and cloths. Fifteen employes from the O-C factory at Newark, Ohio, where production is now centered, will go to Ashton to start manufacturing operations.

The Ashton plant is in the Providence industrial area and was selected because of nearness to mills that weave the all-glass tapes and cloths and to electrical manufacturers whose needs the Ashton plant is primarily intended to serve. It is stated that operationsn at Ashton will in no way curtail production in its other plants.

WALSH CAST-FLUX



The Vacuum-cast flux block of superior quality.

Walsh Cast-Flux blocks are machine-trued to exact size and shape after burning.

THEY LAST LONGER

The excellent results obtained in numerous tanks melting various types of glass has definitely established the efficiency and economy of Walsh Cast-Flux blocks.

Walsh Cast-Flux has a dense, uniform structure; it is burned at higher temperatures, is thoroughly bonded and possesses a low coefficient of expansion.

Walsh Cast-Flux blocks meet the most rigid requirements for tanks operating at higher temperatures . . . they insure greater tonnage, higher quality glass, freedom from defects, longer life and maximum economy.

WALSH REFRACTORIES CORPORATION

Manufacturers of Refractories for the glass industry for over 50 years

4428 North First Street
St. Louis Missouri

CURRENT PRICES OF GLASS-MAKING MATERIALS

FURNISHED BY PRODUCERS, MANUFACTURERS AND DEALERS

Base Materials

		Carlots	Less Carlots
Barium carbonate ($BaCO_3$), Crude, (Witherite) 90%, 99% through 200 mesh	ton	43.00	46.00-49.00
Reduction on precipitated material, $5.00 a ton		45.00	50.00
Barium sulphate, in bags	ton	19.00	24.00
Barium sulphate, glassmaker's, carlots, bulk f. o. b. shipping point	ton	15.00-16.00	18.00
Borax ($Na_2B_4O_7 10H_2O$)	lb.	....	....
Granulated	In bags, lb.	.0215	.027-.0295
Powdered	In bags, lb.	.024	.0295-.032
Boric acid (H_3BO_3) granulated	In bags, lb.	.048	.054-.0565
Calcium phosphate ($Ca_3(PO_4)_2$)	lb.	.07	.07¼
Cryolite (Na_3AlF_6) Natural Greenland (Kryolith)	lb.	.0865-.0875	.0925
Synthetic (Artificial)	lb.	No supplies available.	
Feldspar—(published list prices)			
20 mesh	ton	11.00-13.25	
40 mesh	ton	11.50-13.75	
Granular	ton	11.75-14.00	
Semi-granular	ton	11.00-13.25	
L. C. L., (Min. 2 tons) $3.00 per ton additional plus charge for bags			
Fluorspar (CaF_2) domestic, ground, 96-98% (max SiO_2, 2½%)			
Bulk, carloads, f. o. b. mines	ton	29.00	....
In bags	ton	30.60	40.00-42.50
Kryolith (see Cryolite)			
Lead Oxide (Pb_3O_4) (red lead) (N. Y.)	lb.	.0825	....
In 5 Ton lots	lb.	....	.0875
Less than 5 Tons	lb.	....	.0925
Lime—			
Hydrated ($Ca(OH)_2$-MgO) (in paper sacks)	ton	8.50	8.50
Burnt (CaO-MgO) ground, in bulk	ton	7.00	....
Burnt, ground, in paper sacks	ton	9.00	9.00
Burnt, ground, in 180 lb. drums	Per drum	1.60	1.70
Kiln Dried ($CaCO_3$-$MgCO_3$) 10x30 mesh	ton	1.75	....
Kiln Dried ($CaCO_3$-$MgCO_3$) 16x120 mesh	ton	1.75	....
Nepheline Syenite, f. o. b. shipping point	ton	12.00	15.00
Potassium carbonate—			
Calcined (K_2CO_3) 96-98%	lb.	.065	.0675
Hydrated 80-85%	lb.	.055	.0575
Salt cake, glassmakers (Na_2SO_4) in bags	ton	18.00-20.00	25.00
in bulk		16.50	
Soda ash (Na_2CO_3) dense, 58%—			
Bulk	Flat Per 100 lb	.95	....
In barrels	Per 100 lb.	1.35	....
In bags	Per 100 lb.	1.10	....
Sodium nitrate ($NaNO_3$)—			
Refined (gran.) in bbls	Per 100 lb.	....	2.50-2.90
95% and 97%			
Bulk	Per 100 lb.	1.35	....
200 lb. bags		1.44	1.465
100 lb. bags		1.475	1.50

Special Materials

		Carlots	Less Carlots
Aluminum hydrate (Al $(OH)_3$)	lb.	.026-.029	.04
Aluminum oxide (Al_2O_3)	lb.	.07	.09
Antimony oxide (Sb_2O_3)	lb.	.13	.13½
Arsenic trioxide (As_2O_3) (dense white) 99%	lb.	.03½	.04¼
Barium nitrate ($Ba(NO_3)_2$)	lb.	....	Open price.
Pyrophyllite, (20% Al_2O_3)	ton	9.00	12.00
Sodium fluosilicate (Na_2SiF_6)	lb.	....	
Tin Oxide (SnO_2) in bbls	lb.	....	Open price.
Titanium Oxide (ceramic grade)			
In bags	lb.	.13	.13¼-.13¾
In barrels	lb.	.13¼	.13¾-.14
Zinc Oxide (ZnO)			
American process, Bags	lb.	.06½	.06¾
White Seal, 150 lb. bbls	lb.	.09	.09¼
Green Seal bags	lb.	.08¼	.08½
Domestic White Seal bags	lb.	.08¾	.09
Red Seal, bags	lb.	.07¾	.08
Zircon			
Refined Granular (Milled .01-.02c higher)		.06½	.07-.08

Coloring Materials

		Carlots	Less Carlot
Barium selenite ($BaSeO_3$)	lb.	....	1.40-1.60
(Commercial, 25% Selenium)	lb.	....	.85
Cadmium sulphide (CdS)	lb.	....	1.10-1.15
Cerium hydrate—			
100 lb. drums and 600 lb. barrels	lb	....	.60
Chrome Oxide Green, 400 lb. bbls.	lb.	....	.22-.25
Chromite (99% through 200 mesh)	ton	45.00	48.50
Chromite ore (air floated)	ton	55.00	58.00-73.00
Cobalt oxide (Co_2O_3)			
In bbls. 350 lbs. or more,	lb.	....	1.84
Less than 350 lbs.,	lb.	....	1.94
Copper oxide—			
Red (Cu_2O)	lb.	....	.19-.21
Black (CuO)	lb.	....	.18½-.20
Black prepared	lb.	....	.24
Iron Oxide—			
Red (Fe_2O_3)	lb.	....	.05-.09½
Black (Fe_3O_4)	lb.	.04½	.09
Iron Chromate	lb.	....	.035-.05
Lead Chromate ($PbCrO_4$) in bbls	lb.	....	.135
Lithium Carbonate	lb.	....	1.25
Manganese, Black Oxide (Caucasian)			
In Paper bags	ton	70.00	78.00
In Burlap bags	ton	71.75	79.75
In Casks	ton	74.00	82.00
Neodymium oxalate, 50 lb. drums	lb.	....	4.00
Nickel oxide (Ni_2O_3), black	lb.	....	.35-.40
Nickel monoxide (NiO), green	lb.	....	.35-.37
Potassium bichromate ($K_2Cr_2O_7$)—			
Crystals and Granular	lb.	.08¾	.09-.09¼
Powdered	lb.	....	.09¾-.09¾
Potassium Chromate (K_2CrO_4) 100 lb. kegs	lb.	....	.27
Powder blue	lb.	....	.21-.25
Rare earth hydrate—			
100 lb. drums	lb.	....	.35
325 lb. barrels	lb.	....	.30
Selenium (Se) In 100 lb. lots	lb.	....	1.75
In lesser quantities	lb.	....	1.85
Sodium bichromate ($Na_2Cr_2O_7$)	lb.	.06¾	.07-.07¼
Sodium chromate (Na_2CrO_4) Anhydrous	lb.	.08¾	.08¾-.08½
Sodium selenite (Na_2SeO_3)	lb.	....	1.50-1.65
Sodium uranate (Na_2UO_4) Orange	lb.	....	1.65
Yellow	lb.	....	1.65
Sulphur (S)—			
Flowers, in bbls	Per 100 lb	3.35	3.70-4.10
Flowers, in bags	Per 100 lb.	3.00	3.35-3.75
Flour, heavy, in 250 lb. bbls	Per 100 lb.	2.90	3.25-3.65
Uranium oxide (UO_3) (black, 96% U_3O_8) 100 lb. lots. Black	lb.	....	2.55
Yellow orange	lb.	....	1.65

Polishing Materials

		Carlots	Less Carlots
Emery, Turkish	lb.	.063	.07
Pumice Stone,			
American Ground Italian FFF, FF, F	lb.	.... } open price	
0, 0½, ½, 1.	lb.	.... }	
Putty Powder	lb.	Open price.	
Rotten Stone, (Domestic)	lb.	02¼	.03½
Rouge, Red	lb.	....	.16
Black	lb.	....	.18

"Ceramic" COLORS and CHEMICALS POINT TO PROFITS

GLASS COLORS Vitrifiable Colors for Banding, Spraying and Screening; Alkali-resisting, Acid-resisting, Satin Finish, High Fire Convexing, Low Fire and Squeegee Colors; White or Colored Weather-resisting Enamels; Colored or Crystal Ices.

OILS Balsam Copaiba, Damar Varnish, French Fat Oil, Ground Laying Oil, Oil of Copaiba, Printing Oil, Squeegee Oils for Low Fire, High Fire or Overlapping Work, Venice Turpentine.

CHEMICALS Aluminum Hydrate, Antimony Oxide, Arsenic Oxide, Barium Carbonate, Bone Ash, Cadmium Sulphide, Cerium Hydrate, Chromium Oxide, Cobalt Oxide, Copper Oxide, Iron Chromate, Iron Oxides, Fluorspar, Kryolith, Manganese Dioxide, Powder Blue, Potassium Bichromate, Sodium Fluoride, Sodium Silico Fluoride, Sodium Uranate, Sodium Selenite, Selenium, Titanium Dioxide, Zinc Oxide.

DECORATING SUPPLIES Brushes, Spatulas and Knives, and Color Grinding equipment.

Our Mr. W. F. WENNING and Mr. F. H. KOHNE have rooms at the Lord Baltimore during the meeting. Feel free to discuss your color problems with them.

"Ceramic" COLORS

CERAMIC COLOR & CHEMICAL MFG. CO.

NEW BRIGHTON, PA., U.S.A.

PLASTICS ARE NOT GLASSES

The plastics are new products artificial,
For many purposes quite beneficial;
But we've reached a pretty pass
When their makers name them "glass,"
And glassmen rise to call it prejudicial.

The plastics have organic composition;
They do not very well resist ignition;
They are formed when chemists wise
Make some stuff polymerize;
They have a tough and pliant disposition.

The fact that some of them may be transparent
Has given rise to nomenclature errant.
But to call them "glass" is wrong,
And we've known it all along.
The Trade Commission soon will say they daren't.

The doughnut offers bakers no temptation
To give a "glassy" name to that creation,
Although one can look right through it,
As he can through melted suet,
Transparency remains its sole relation.

And so it is with plastics, we aver:
In hardness, they are quite inferior;
Durability is low—
Solvents make them yield and flow.
As lenses, they produce a dismal blur.

But "glass" belongs, the ancient names among,
A root-word in the Anglo-Saxon tongue.
And its use is so pre-emptied
It were well if none attempted
To have it on synthetic infants hung.

In glass, just inorganic stuff is used;
At white heat are its parent oxides fused;
It is natural as lava;
And we cannot bear to have a
Great name so inconsistently misused.

By those in thinking physical well schooled,
A glass is known as liquid undercooled
Reaching temperatures frigid
With no crystals, but quite rigid,
Whose behavior by viscosity is ruled.

Plasticity's a thing no glass possesses.
Such usage every physicist distresses.
For, if it will yield at all,
Any load, however small,
Will bend hot glass and leave no lasting stresses.

Elastic, hard, of splendid durability,
And workable, because of hot ductility,
Is this substance so unique
Among useful things men seek,
And calling plastics glass is mere futility.

—S. R. S.

TOLEDO TRIAL

(*Continued from page* 166)

industry, as well as glass. Most important exhibits introduced to date include copies of various licensing agreements which were entered into by the various firms.

While much of the ground was covered in the TNEC hearing the present case is so much more extensive that observers think many of the charges alleged against the respective defendants are news to each other.

Mr. Isseks has indicated the rest of the government's case will take at least all of the month of April and perhaps part of May, even if Judge Kloeb finds it possible to continue it steadily. The judge intends to recess the trial for his regular spring criminal docket in May. He is hopeful that the government's side of the glass case will be completed then.

Cleveland Tramrail batch-handling systems are available for either manual or electric operation. Illustrated above is a manual system. The operator is discharging the batch at the doghouse.

SAVINGS PAY FOR THIS SYSTEM...

Because a Cleveland Tramrail batch-handling system solves the segregation problem and makes possible delivery of mix to the doghouse that is uniformly accurate 24 hours a day, a consistently good glass is produced with losses reduced to a minimum.

The savings from decreased losses, will pay for the system in a short period. In addition, many other advantages are secured.

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WILL SURVEY THE HANDMADE TABLE GLASSWARE INDUSTRY

The Economic Survey of the Handmade Tableware Industry, decided upon at a meeting of manufacturers held in Pittsburgh last June, is about to get underway. Questionnaires have been completed and will be mailed to the trade the first week in April. Both cutters and glass manufacturers are being included in the survey.

The idea of the survey was decided at a meeting of the industry held in Pittsburgh last June. A representative of the Specialties Division of the Department of Commerce was present by invitation and was requested to discuss with them the cause and cure of some of the ills from which the industry was suffering. He called attention to the utter lack of data, and the need of a survey as the first step toward correcting any bad situations.

Glassmen present at the meeting quickly saw the point and voted on the spot to attempt an economic survey, which the Department of Commerce would undertake for them. A letter was sent to absentee companies and as a result about 30 concerns agreed to cooperate and underwrite the expense.

Publication of the results will follow immediately after the data secured by questionnaire have been compiled and consolidated. This publication will take the form of a booklet to be entitled "The Handmade Table Glassware Industry." The broad ground to be covered and the essential value of the picture of the industry's operations that will be secured for the survey, can be seen from the chapter headings, which have been tentatively established as follows:

I. Foreward.

II. History of American hand-made table glassware, including present location of plants.

III. Description of methods of manufacture, including reference to the types and amounts of raw materials and supplies used by this industry, the expenditures for buildings, machinery, equipment, etc.

IV. Statement of profits and losses during the years 1937-1940, inclusive, and history of the "cooperative" movement in the hand-made glassware industry.

V. Analysis of costs of making hand-made tableware showing their relationship to selling price.

VI. Review of trends in wages and employment including information on strikes, unionization, "the move system," etc.

VII. Analysis of sales by types of ware and by marketing channels.

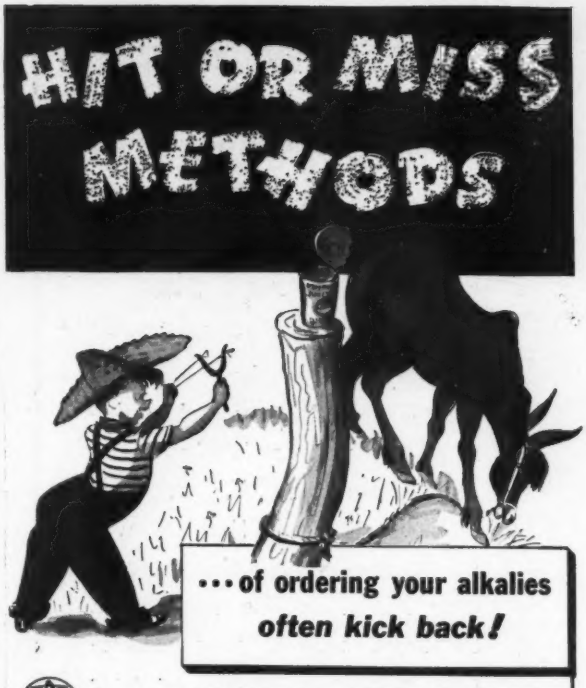
VIII. Review of recent trends in our foreign trade showing the relationship of imports to domestic production, etc.

IX. The cutting and decorating industry.

X. Consumer information covering such factors as the selection and care of hand-made glassware, competive products, etc.

XI. Recommendations to the industry resulting from analysis of the data obtained during the survey.

• Ray S. Goddard, consulting engineer, has removed his office to 11 Mt. Lebanon Boulevard, Pittsburgh (16), Pa.



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MODERN DISTRIBUTING FACILITIES . . . Three of America's largest alkali plants, located in important industrial centers and over 100 stock points assure prompt delivery and efficient routing of your orders for Solvay Alkalies.

YOUR PROBLEMS CONCERNING THE USE OF ALKALIES ARE SOLVAY'S . . . Solvay Technical and Engineering Service Division will help you get the most from your alkalies. Write for complete information.

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More than 99.50% Sodium Carbonate *(on a dry basis.)*

SOLVAY DUSTLESS CALCINED 98-100% POTASSIUM CARBONATE
Also Granular Hydrated 83-85%

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90 WEST STREET, NEW YORK CITY

INVENTIONS AND INVENTORS

(*Continued from page* 173)

ber inward to the conveyor at the bottom of the collecting chamber, and by adjusting the interval between them, control of the mat width is provided. Simpson's patent 2,230,271 proposes means of making a sliver or cord of interfelted glass and asbestos fibers. The fibers are blown so as to fan out over a roller so as to give a loose web into which the asbestos fibers can be fed; the web is then drawn together through a restriction to form the interfelted sliver.

To provide a glass fiber which mats and tangles more readily than ordinary straight fibers, various means have recently been suggested. The latest is Games Slayter's patent 2,230,272 in which crimping rollers act in pairs on the fiber stream in a continuous step immediately succeeding the blowing process.

The fourth Owens-Corning patent, 2,231,815 to Ralph C. Newman, Corning, N. Y., and John W. Romig of Rumford, R. I., claims as a new product, a yarn comprising an annular twisted core of intermingled fibers and a seamless external coating of fibers.

Two patents were issued to Wm. F. Lamela, East Paterson, N. J., for electric cables utilizing glass wool in their wrappings. These are 2,230,887 and 2,230,888, assigned to the Okonite Co. of Passaic.

Glass Blocks

In patent 2,232,798 Ormond H. Paddock, of Toledo (Libbey-Owens-Ford) cites the loss in the heat insulative capacity of glass block wall structures due to the high conductivity of the mortar bond, and proposes an interrupting air space in the mortar.

The breakage of glass blocks in wall structures frequently is not assignable to known causes. Rob R. McGregor of Pittsburgh suggests in patent 2,232,465, assigned to Corning Glass Works, that the sand grains which form the bonding layer on the blocks may possibly cause trouble due to scratching when the blocks are struck with a trowel. He proposes replacing quartz sand by softer mineral grains such as brucite and fluorite.

Miscellaneous Products and Use

A polarizing headlight system for automobiles was patented by Leon Pollack of Brooklyn: 2,230,262. Patent 2,231,580 to Max Jacoby of Berlin, Germany, is concerned with illuminated advertising devices.

A wall construction utilizing panels of transparent glass was patented by Samuel F. Cox and Percy E. Knudsen of Pittsburgh (2,230,348, assigned to P. P. G. Co.).

A.S.T.M. REFRACTORY MANUAL

The 1940-1941 edition of the Manual of A.S.T.M. Standards on Refractory Materials, prepared by Committee C-8 in Refractories, has just been released. The manual presents in their latest approved form all of the A.S.T.M. specifications, tests, and definitions covering these materials and gives other information and data significant in the field of refractories. This edition supersedes the one published in 1937 and includes considerable additional material. Complete with an index, copies of this 180 page manual can be obtained from A.S.T.M. Headquarters at $1.50 in board cover, or $1.75 in cloth.

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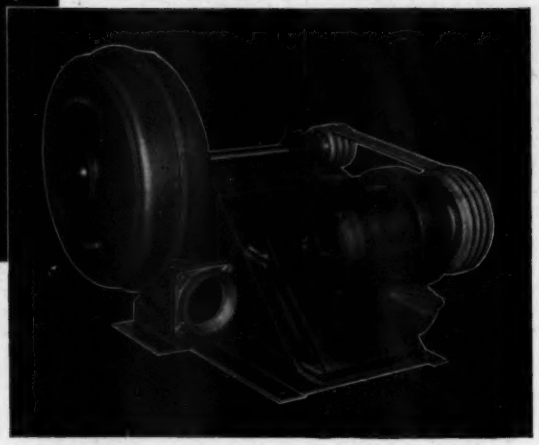

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